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FINAL
WORK PLAN

FOR SITE INSPECTIONS
AT
SITES 3, 7, 43, 44, 54, 63, 65, 80, AND 82

CAMP LEJEUNE MILITARY RESERVATION
JACKSONVILLE, NORTH CAROLINA

AUGUST 1991

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1.0 INTRODUCTION

NUS Corporation (NUS) developed this Work Plan for nine site inspections for the Department of the Navy, Atlantic Division, for the Camp Lejeune Military Reservation (CLEJ), in response to a request by the Department of the Navy, under Contract No. N62470- 90-R-7629. CLEJ includes Marine Corps Base (MCB), Camp Lejeune, and Marine Corps Air Station (MCAS), New River. Environmental studies are being conducted at the CLEJ as part of the Department of the Navy's Installation Restoration Program (IRP). This Work Plan is being developed as part of the Navy's IRP.

One of the first program objectives was to collect and evaluate historical evidence indicating existence of pollutants that may have contaminated the installation or that pose an imminent health hazard on or off the facility. The Initial Assessment Study (IAS) (Water and Air Research, Inc., March 1983), essentially equivalent to EPA's Superfund Program Preliminary Assessment (PA), accomplished this goal and identified 76 suspect sites. This study concluded that 22 of these 76 sites warranted further study. Seven of the sites dropped by the IAS require more data to justify "no further actions."

The second objective of the program is to determine, via sampling and analysis activities, whether specific toxic and hazardous materials identified in the IAS, and possibly other contaminants, exist in concentrations considered to be hazardous. This Work Plan fulfills this part of the objective for the nine sites identified below.

- IAS Site 7 - Tarawa Terrace Dump
- IAS Site 63 - Verona Loop Dump
- IAS Site 54 - Crash Crew Burn Pit
- New Site 82 - Piney Green Road VOC Area
- New Site 80 - Paradise Point Golf Course
- IAS Site 3 - Old Creosote Plant
- IAS Site 43 - Agan Street Dump
- IAS Site 44 - Jones Street Dump
- IAS Site 65 - Engineer Area Dump

The nine sites listed above include the following:

- Six sites reviewed in the IAS previously recommended for "No Further Action" but requiring additional data to perform a risk assessment and verify the previous decision.

- One IAS site requiring additional data to perform a risk assessment and evaluate whether additional investigation is warranted.

- Two recently identified sites requiring data to perform a risk assessment and determine whether these sites pose a risk to human health and the environment.

A Site Inspection Report will be prepared for each site identifying the results of the investigation and one of the three recommendations below:

- No contaminants of concern were detected and/or the risk assessment demonstrates there is no threat to human health or the environment. The site should therefore be dropped from the Installation Restoration Program.

- Some contaminants were detected at low levels, but additional data is required prior to determination of site status.

- Extensive contamination was detected and a remedial investigation (RI) should be conducted.

These recommendations will be supported by the sampling and analysis to be conducted at each site, as outlined in this Work Plan.

The work activities proposed in this document are based upon the available history of the site, current data from recent investigations, and discussions in the scoping meeting of September 27 and 28, 1990. The plan focuses on sampling and analytical efforts that will provide data to define present and future risks to human health and the environment as well as to evaluate potential remedial alternatives.

The Work Plan is organized into 13 sections. This Introduction is Section 1.0. Section 2.0, Base Background, presents an overview of the CLEJ in North Carolina. Sections 3.0 through 11.0 provide information on each of the 9 sites mentioned earlier. Specifically, this includes a brief history and physical description of the site, an initial evaluation, the rationale for the site investigation, and the site investigation tasks to be performed. Section 12.0 contains the scoping for background samples to be taken. Finally, Section 13.0, Project Management Approach, discusses the project organization, quality assurance and data management, and schedule for the project. In addition, Appendix A provides the Target Compound List (TCL) of analytes.

The Work Plan is one of a series of planning documents prepared for these sites; additional documents include

- Sampling and Analysis Plan
  - Field Sampling Plan and Quality Assurance Project Plan - Volume I
  - Laboratory Quality Assurance/Quality Control Plan - Volume II
- Health and Safety Plan

Each of these documents is presented in a separate volume.

The distribution list for these documents follows:

LANTNAVFACENGCOM
Commander Atlantic Division Naval Facilities Engineering Command Attn: Code 09A2124, Mr. D.A. Bourcher, P.E. Norfolk, Virginia 23511-6287
ACTIVITY (MCB CAMP LEJEUNE)
Commanding General Marine Corps Base Camp Lejeuene, North Carolina 28542-5001
MARTIN MARIETTA
Martin Marietta Energy Systems, Inc. P.O. Box 2003 Attn: Marilew Bartling Analytical Chemistry Department Oak Ridge, Tennessee 378331-7440

TRC Members
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United States Environmental Protection Agency, Region IV Attn: Mr. Arthur Linton Federal Facilities Coordinator 345 Courtland Street Atlanta, Georgia, 30365
N.C. Department of Environment, Health, and Natural Resources Attn: Mr. Preston Howard 7225 Wrightsville Avenue Wilmington, North Carolina 28403
Jerry Bittner Jacksonville City Manager P.O. Box 128 Jacksonville, North Carolina 28541
Mr. Cameron Lanier 612 College Street Jacksonville, North Carolina 28540
Colonel (Retired) Jack Mader 1216 Country Club Road Jacksonville, North Carolina 28540
Department of Environment, Health and Natural Resources Attn: Jack Butler, Superfund Section P.O. Box 27687 401 Oberlin Road Raleigh, North Carolina 27611
Mr. Ray Humphries 514 Brynn Marr Road Jacksonville, North Carolina 28540

2.0 BASE BACKGROUND

This section provides a brief review of the history and description of the Camp Lejeune Military Reservation. The primary sources of this information are as follows:

- IAS Report (Water and Air Research, 1983)
- Site Summary Report (Environmental Science & Engineering, 1990)
- Multiple-Use Natural Resources Management Plan (Camp Lejeune, North Carolina, 1987)
- Master Plan Update, Camp Lejeune Complex, North Carolina (Camp Lejeune, North Carolina, 1984)

2.1 GENERAL

Camp Lejeune Military Reservation (CLEJ) is located in Onslow County, North Carolina. Figure 2-1 is a location map of Camp Lejeune that identifies approximate locations of the sites covered in this work plan. The facility currently covers approximately 170 square miles and is bisected by the New River. The Atlantic Ocean forms the southeastern boundary of the base. The western and northeastern boundaries are U.S. 17 and State Road 24, respectively.

There are five major areas of development at Camp Lejeune: Camp Geiger, Montford Point, Courthouse Bay, the Rifle Range area, and Marine Corps Air Station (MCAS) New River. MCAS New River is a helicopter base and is a separate command on the west side of the New River. Helicopter Outlying Landing Field (HOLF) Oak Grove, approximately 25 miles to the north, and Outlying Landing Field (OLF) Camp Davis, 10 miles to the southwest, are also under the command of MCAS New River. HOLF Oak Grove is no longer active and is under caretaker status.

Within 15 miles of Camp Lejeune are three large, publicly owned tracts of land: Croatan National Forest, Hofmann Forest, and Camp Davis Forest. In addition to the forested areas, the low elevations of the coastal plain have created vast acreage of inland and coastal wetlands (ES&E, 1990).

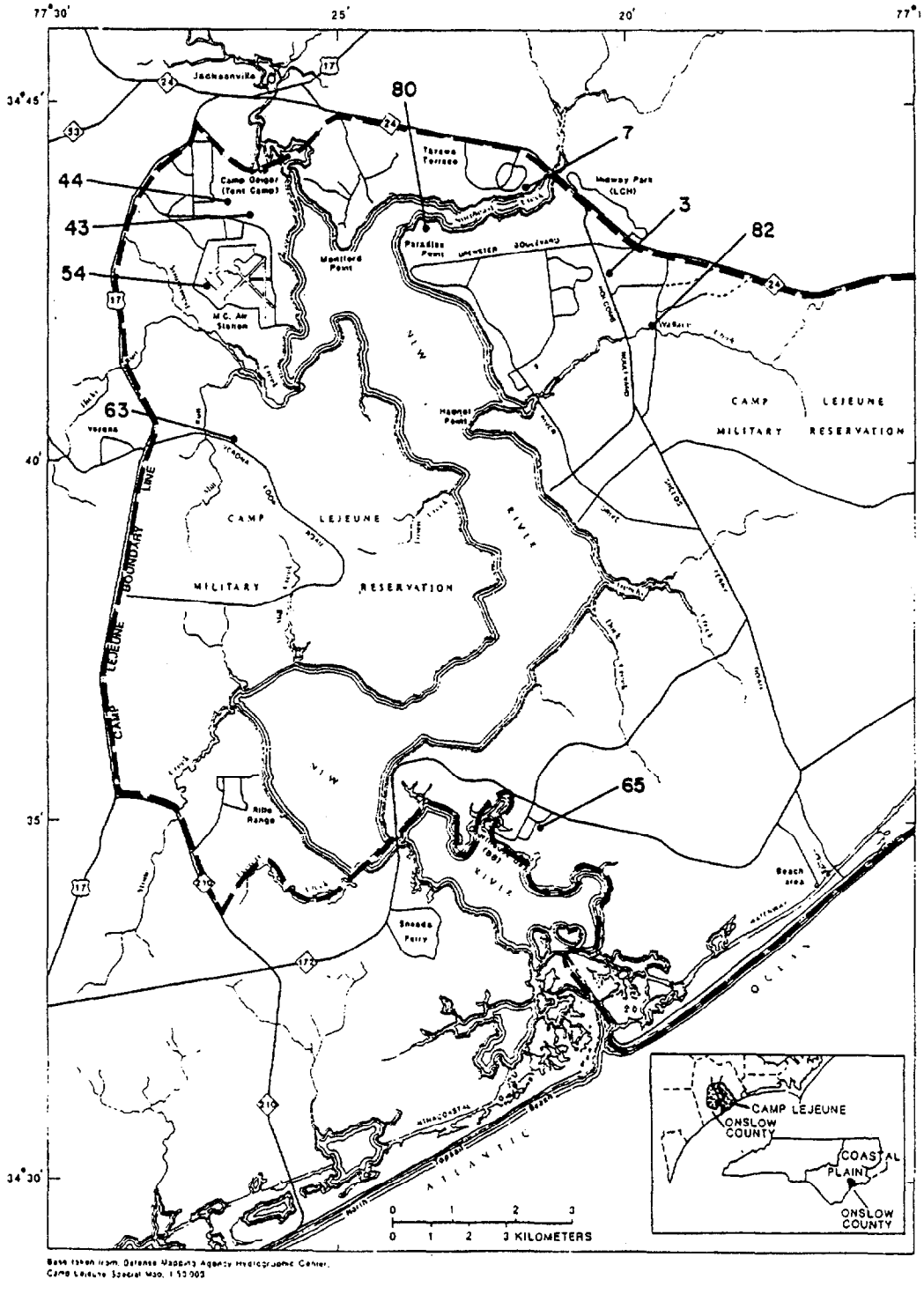
2.2 SITE HISTORY

Construction of MCB Camp Lejeune began in 1941 at Hadnot Point, where functions were centered. During construction, 9 million board feet of timber were harvested from the reservation. From 1944 to 1954, a sawmill was operated by base personnel.

During World War II and the Korean and Vietnam conflicts, Camp Lejeune was used as a training area to prepare Marines for combat. The base serves as the home base for the Second Marine Division, and Fleet Marine Force (FMF) units have also been stationed as tenant commands.

Construction in the Montford Point, Camp Geiger, and Courthouse Bay areas was completed by 1945. Montford Point, originally developed for training of troops, is now used for Marine Corps Service Support Schools. Courthouse Bay hosts amphibious training, while Paradise Point is the site of housing for commissioned personnel. Noncommissioned personnel housing is provided at locations such as Tarawa Terrace I and II and Midway Park.

The U.S. Naval Hospital opened in 1943 and has served military personnel during World War II and the Korean War. In addition, the hospital provides medical services for all assigned military personnel and their dependents.



Base taken from Defense Mapping Agency Hydrographic Center, Camp Lejeune Special Map, 1:50,000

FIGURE 2-1
LOCATION MAP
CAMP LEJEUNE MILITARY RESERVATION

IAS site numbers are identified above with approximate locations.

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MCAS New River was set up as a separate command in 1951. At that time it was called Peterfield Point, but the name was changed to New River in 1968. In 1942, three new runways were added and the station came under the jurisdiction of MCAS Cherry Point. During this time PBJ Squadron was based here and the facility was also used for glider training. During the Korean Conflict, it was used as a helicopter training base and for touch-and-go training for jet fighters.

In 1968, Maine Corps Outlying Landing Field (MCOLF) Oak Grove was placed under the jurisdiction of MCAS New River. The field was used as a helicopter base and renamed HOLF Oak Grove. During World War II, the field was under the command of MCAS Cherry Point. At the end of the war, all structures were destroyed with the exception of the runways (ES&E, 1990).

2.3 PREVIOUS INVESTIGATIONS

An Initial Assessment Study was conducted by Water and Air Research, Inc., of Gainesville, Florida, in 1983. The purpose of the report was to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations. Based on information from historical records, aerial photographs, field operations, and personnel interviews, a total of 76 potentially contaminated sites (areas of concern or AOCs) were identified. The initial assessment evaluated each site with regard to contamination characteristics, migration pathways, and potential receptors. The results of the study indicated that while none of the sites posed an immediate threat to human health or the environment, 21 areas warranted further investigation to assess long-term impacts. During the initial investigation at the 21 AOCs, an additional AOC (Site A at MCAS New River) was identified and included in the ongoing investigations, for a total of 22 sites.

Based on the recommendations of the Initial Assessment Study, an RI/FS at MCB, Camp Lejeune, was initiated in 1984 to study the 22 sites. The first round of sample collection and analysis was conducted by Environmental Science and Engineering, Inc. (ES&E), beginning in July 1984. During the investigation, 55 shallow groundwater monitoring wells were installed and a total of 75 groundwater samples were collected for analyses. In addition to the groundwater samples, 56 soil samples, 7 surface water samples, 8 sediment samples, and 2 fish tissue samples were collected and chemically analyzed. An Evaluation Report presenting the data generated by this round of sample collection was prepared in January 1985. The report recommended additional monitoring for all of the investigated sites. An additional round of sample collection and analysis was conducted by ES&E in 1986/87. In this sampling episode, 29 additional monitoring wells were installed and a total of 113 new and existing monitoring wells were sampled. In addition, 54 soil samples, 44 surface water, and 41 sediment samples were collected and analyzed. An Evaluation Report was submitted to LANTDIV in July 1987 which documented the data generated during the second round of sampling.

In 1988, O'Brien and Gere Engineers was retained by The Department of the Navy, Atlantic Division (LANTDIV) under its Underground Storage Tank Program. The firm was contracted to provide necessary hydrogeologic services. Such services included investigating the hydrogeology and evaluating the extent of fuel leakage from the underground storage tanks and associated transfer lines at the Hadnot Point Fuel Farm (Site 22).

ES&E was retained by LANTDIV to prepare an Interim Remedial Investigation report consolidating all documents produced to date concerning the 22 potentially contaminated sites identified by Air Research, Inc. The report describes the contamination assessments performed at the areas of concern, indicates potential migration pathways, summarizes all rounds of analytical data collected, and provides recommendations for further action. The Final Draft Report was issued in June 1990.

Two additional sites have been identified as potentially contaminated. These sites (80 and 82) will be evaluated for the first time as part of the proposed site inspections discussed in this Work Plan.

One of the sites covered in this Work Plan, Site 54: Crew Burn Pit, was part of the 22 sites originally identified as requiring confirmation of contamination and is included in ES&E's 1990 report. In this Work Plan, NUS proposes additional data gathering required to perform a risk assessment and determine whether the contaminants present pose a risk to human health or the environment.

The remaining six sites (Sites 3, 7, 43, 44, 63, and 65) were originally identified as requiring no further action in the 1983 Water and Air Research, Inc., report. This Work Plan proposes investigations to further characterize these sites and provide recommendations as to their status.

2.4 TOPOGRAPHY AND SOILS

The surface configuration of the inland portion of Camp Lejeune is related to (1) undissected, nearly level marine sediments which comprise the interstream areas, (2) short, convex slopes and narrow valleys made by streams, and (3) low ridges formed by wind deposits of coastal sand with associated tidal marshes as at the Outer Banks. The elevation of Camp Lejeune ranges from sea level to about 72 feet.

The inland valley bottoms range from 5 to 30 feet below the uplands. The slope of the valley sides may be as high as 50 to 60 percent, and the length of slopes range from 20 to about 250 feet. The valley bottoms or flood plains vary in width from a few feet to several hundred feet.

The soils on the flood plains are classified according to the soil conservation service as poorly drained Muckalle loam; very poorly drained Dorovan muck; and poorly drained Bohicket silty clay loam, which occurs on wide estuarial flood plains of coastal creeks.

The soils on the valley sides are well-drained Marvyn loamy fine sand and moderately well-drained Craven fine sandy loam.

The soils that join the valleys and side slopes and which extend a short distance away from the valley sides consist of well-drained Baymeade fine sand, Norfolk loamy fine sand, and Norfolk loamy fine sand. Adjacent to the more convex areas described above are slightly convex areas of moderately well-drained Foreston loamy fine sand, Goldsboro fine sandy loam, and Onslow loamy fine sand.

The soils on undulating and low ridges near the edge of the mainland and near coastal creeks are excessively drained Alpin fine sand, Kureb fine sand, and Wando fine sand soils. In depressions of this area are found the moderately well and somewhat poorly drained Pactolus fine sand, poorly drained Leon fine sand, and very poorly drained Murville fine sand soils.

The soils on broad, nearly level interstream areas are somewhat poorly drained Lenoir loam, Lynchburg fine sandy loam, and Stallings loamy fine sand soils joining the slightly convex areas. Near the center part of the interstream areas are poorly drained Leon fine sand, Rains fine sandy loam, and Woodington loamy fine sand soils. In the center and in depressions are very poorly drained Croatan muck, Murville fine sand, Pantego mucky loam, and Torhunta fine sandy loam soils.

The soils of the Outer Banks' portion are excessively drained Newhan fine sand, on ridges and dunes, and moderately well drained Corolla fine sand and poorly drained Duckston fine sand soils in depressions. Poorly drained Bohicket silty clay loam and very poorly drained Lafitte muck soils are on tidal marshes, and somewhat poorly to moderately well drained Yaupon fine sandy loam are on dredge spoil (Camp Lejeune, North Carolina, 1987).

2.5 SURFACE WATER HYDROLOGY

Approximately 70 percent of MCB Camp Lejeune is in the broad, flat interstream areas where drainage is poor and soil is often wet. The drainage at Camp Lejeune is predominantly toward the New River, although the coastal areas tend to drain directly into the Atlantic Ocean through the

Intracoastal Waterway. The natural drainage has been changed in developed areas by drainage ditches, storm sewers, and extensive asphalt and concrete areas.

The dominant surface water feature at MCB Camp Lejeune is the New River, which receives drainage from most of the base. The New River flows in a southerly direction and empties into the Atlantic Ocean through the New River Inlet. Several small coastal creeks drain the area of MCB Camp Lejeune that is not drained by the New River and its tributaries. These creeks flow into the Intracoastal Waterway, which is connected to the Atlantic Ocean by a series of inlets. Stream flow in the New River in the area of MCB Camp Lejeune and the average annual runoff of the MCB Camp Lejeune area have not been determined. The water in the New River at MCB Camp Lejeune is brackish, shallow, and warm.

Flooding is a potential problem for areas of the base within the 100-year flood plain. The U.S. Army Corps of Engineers has mapped the limits of the 100-year flood plain at Camp Lejeune at 7.0 feet mean sea level (MSL) in the upper reaches of the New River, which increases to 110 feet MSL on the open coast [ES&E, 1990].

2.6 GEOLOGY

Camp Lejeune is located in the Atlantic Coastal Plain physiographic province. The Coastal Plain is underlain by unconsolidated deposits of sand, and clay with minor amounts of gravel. Also noted are minor amounts of marl shell rock. Regionally, these deposits are gently dipping to the southeast in a thickening wedge that overlies the bedrock. These shallow deposits constitute the unconfined aquifer (water table) of the coastal plain. Because of the permeable nature of these sediments, they are vulnerable to both saline encroachment and surface contaminants.

In the Camp Lejeune area, the unconsolidated sedimentary deposits are approximately 1,400 to 1,700 feet thick. The following discussion involves only the uppermost 300 feet of the sequence, which represents the source of fresh water for the base.

At the top of the sequence, undifferentiated Pleistocene and Recent sands and clays form the seaward thickening band of sediments. These deposits can reach a thickness of 35 feet. Beneath these deposits are seven sand limestone aquifers separated by confining units of silt and clay. The seven aquifers are the surficial, Castle Hayne, Beaufort, Peedee, Black Creek, and Upper and Lower Cape Fear. Less permeable clay and silt beds separate the aquifers and serve as confining or semi-confining units, which impede the flow of groundwater from one aquifer to another.

Fresh water is present in the surficial and Castle Hayne aquifers at MCB Camp Lejeune. Fresh water extends to a depth of 300 feet. Brackish water is usually found deeper than 300 feet below MSL.

The surficial aquifer at MCB Camp Lejeune is composed of Quaternary and Miocene sand, silt, and clay. The aquifer ranges in thickness from 0 feet in the channels of the New River and its tributaries to 75 feet in the southwestern portion of Camp Lejeune.

The Castle Hayne aquifer is composed of sand and limestone of Oligocene and Middle Eocene age. The upper portion of the aquifer consists primarily of unconsolidated sand. The lower portion consists of partially consolidated sand and limestone. Thin clay layers are found throughout the unit. The Castle Hayne aquifer thickens toward the southeast, from 175 feet in the northern portion of the base to 375 feet at the coast. The Castle Hayne aquifer is approximately 340 feet thick in the Hadnot Point Area (ES&E, 1990).

2.7 HYDROGEOLOGY

Some of the formations in the Coastal Plain are permeable, can be defined as aquifers, and are of wide areal extent. Hydraulic connections between these aquifers are common though complex

interbedding creating a complex hydrologic system, which is a common characteristic of Coastal Plain sediments. This complex system may include streams and lakes where the aquifers are at or near the land surface.

In general, the hydrologic system at Camp Lejeune consists of an unconfined (water table) aquifer and semi-confined aquifer. The unconfined aquifer extends from the water table to the first significant confining unit.

The water table at Hadnot Point Industrial Area (HPIA) is found at depths ranging from 6.17 to 22.36 feet below the land surface. Water-level fluctuations in the area range from 1 to 4 feet and are attributed to seasonal variations.

In general, shallow groundwater flows toward the New River. The direction of flow actually ranges from south-southwest in the northern corner of HPIA to west-southwest in the southwest. Groundwater mounding appears to occur in the west-central and southeastern areas. This may be due to increased surface infiltration and a drainage ditch in the west-central and southern sections, respectively. The horizontal flow gradient over most of the area is approximately 0.003 ft/ft, but increases to 0.02 ft/ft in the southwest corner of the site.

Water levels measured in deep and intermediate wells are similar to those observed in nearby shallow wells. Additional data is required before a potentiometric surface map can be generated for the deep aquifer; however, it is expected that deep groundwater flows to the east-southeast, towards the Atlantic Ocean. Small-scale regional changes in groundwater flow may occur in the deep aquifer due to local pumping of water supply wells. The U.S. Geological Survey (USGS) notes that flow gradients may range from 15 feet/mile (0.0028 ft/ft) in areas unaffected by pumping to 150-200 feet/mile (0.0284-0.0378 ft/ft) in areas near active water supply wells.

A 72-hour pumping test performed at HPIA by ES&E in 1987 indicates average transmissivity and storage coefficient values of 9.6×10^{-3} gpd/ft and 8×10^{-4}, respectively, for the limestone portion of the deep (Castle Hayne) aquifer. These values are in general agreement with those reported by the USGS. Hydraulic conductivity for the Castle Hayne is reported by the USGS at an average of 35 ft/day with a range between 19 and 82 ft/day.

Further analysis of the Hunter/ES&E deep pumping test data indicates that the limestone portion of the deep aquifer is semi-confined. Recharge occurs through a clayey layer overlying the aquifer. Hydraulic conductivity for this layer is estimated at 4.6×10^{-3} ft/day, typical of silty sands and silty clays (ES&E, 1990).

Water Supply

The water supply for Camp Lejeune is entirely from water wells located within the boundaries of the installation. Groundwater is the source of water for Camp Lejeune, as is the case for most of the central Coastal Plain of North Carolina. Information regarding groundwater conditions in the Coastal Plain is provided in the report Groundwater Evaluation in the Central Coastal Plain of North Carolina, prepared by the North Carolina Department of Natural Resources and Community Development.

Sediments underlying the area are subdivided into four principal aquifer systems; the unconfined Water Table Unit, the confined Castle Hayne and the Cretaceous Upper Sand and Lower Sand Units. The Cretaceous Lower Sand Unit is the principal water-bearing unit in the Coastal Plain. The unit dips to the southeast and ranges from 200 to 700 feet in thickness. Since the late 1960s, water levels in the Cretaceous aquifer system have declined due to large-scale municipal and industrial withdrawals. Water levels near some pumping centers have declined 80 feet since 1965.

The Pee Dee Stratigraphic Unit of the Cretaceous Lower Sands underlies the Castle Hayne Unit. It is a semi-confined aquifer whose water-bearing sands yield moderate amounts of water. The water is a

soft, sodium bicarbonate type except in those areas where calcareous beds cause it to be moderately hard. Heavy withdrawals from the Cretaceous Lower Sand Unit are reflected in leakage from the Upper Sand Unit. The Cretaceous Upper Sand Unit consists of dark green or gray glauconitic or clayey sands interbedded with massive dark gray clay beds. The unit outcrops in Duplin, Greene, Lenoir, and Pitt Counties. It thickens to the east to between 60 and 80 feet. The unit is overlain by the Castle Hayne Unit and separated from it by a massive clay layer 20 to 30 feet thick.

The Castle Hayne Unit is a highly permeable, semi-confined aquifer capable of yielding large amounts of water. It is an important aquifer in the eastern part of the state. It yields a hard, calcium bicarbonate type water. The Castle Hayne Unit varies from shell limestone to sand with shell fragments. It occurs as a continuous unit in Onslow and nearby counties. The unit thickness increases to more than 400 feet in the eastern part of the central Coastal Plain.

The elevation of the top of the Castle Hayne Unit is zero feet, while the thickness of the Unit is 300 to 350 feet at Jacksonville. Interpretation of the data of the above-mentioned groundwater report indicates that the wells of Camp Lejeune are all in the Castle Hayne Unit. It is also overlain partly by the individual clay layers present throughout the overlying Yorktown aquifer.

Hydrographs of the Castle Hayne Unit exhibit cycles of increasing water levels during the late fall, winter, and early spring, followed by decreasing water levels during the remainder of the year. Static water levels in the Castle-Hayne wells generally are within 0 to 20 feet below the land surface. Indications are that the Castle Hayne Unit is not being affected by withdrawals from the unit itself or from the underlying Cretaceous aquifer system. Typically, the yields of municipal and industrial wells in the Castle Hayne Unit range from several hundred to 1,000 gallons per minute (Camp Lejeune, North Carolina, 1987).

2.8 LAND USE

Within 15 miles of Camp Lejeune are three large, publicly owned tracts of land; The Croatan National Forest, The Hoffman Forest, and Camp Davis Forest. Because of the low elevations in the Coastal Plain, the majority of the area is composed of wetlands. In addition these areas have been exploited to some extent by agriculture and silviculture interests. There is a growing concern on a state and national level that these ecosystems, unique to the Coastal Plain, require a protected status to survive.

The remaining land use surrounding MCB Camp Lejeune is agricultural, with typical crops of soybean, small grains, and tobacco. Productive estuaries along the coast support commercial fish and shellfish industries. Tourism and residential resort areas have stimulated the regional economy.

The MCB Camp Lejeune is predominantly tree covered, with large amounts of softwood and substantial stands of hardwood species. Of MCB Camp Lejeune's 112,000 acres, more than 60,000 are under forestry management. Timber-producing areas are under even-aged management with the exception of those areas along major streams and in swamps. These areas are managed to provide for both wildlife habitat and erosion control. Smaller areas are managed for the benefit of threatened or endangered wildlife species.

Some areas of the New River at MCB Camp Lejeune are classified under Title 15 of the North Carolina Administrative Code as Class SC, while others are classified as Class SA. Class SC waters are usable for fishing and secondary recreation, but not for primary recreation or shellfish marketing. Class SA waters are the highest estuarine classification, usable for shellfish marketing.

The ecosystems found at MCB Camp Lejeune include terrestrial (or upland), wetland, and aquatic communities. The terrestrial ecosystems contain four habitat types--long leaf pine, loblolly pine, loblolly pine/hardwood, and oak/hickory. Loblolly pine is the main timber stand of the area. The wetlands ecosystems vary from those bordering freshwater streams to salt marshes along coastal

estuaries. The aquatic ecosystems consist of small lakes, the New River estuary, numerous tributary creeks, and part of the Intracoastal Waterway.

The wetland ecosystems on MCB Camp Lejeune include five habitat types--pond pine or pocosin, sweet gum/water oak/cypress/tupelo, sweet bog/swamp black gum/red maple, tidal marshes, and coastal beaches. The tidal marsh at the mouth of the New River on MCB Camp Lejeune is one of the few remaining North Carolina coastal areas relatively free from filling or other man-made changes. Coastal beaches along the Outer Banks and Intracoastal Waterway of MCB Camp Lejeune are used for recreation and to house a small military command unit on the beach. The Marines also conduct beach assault training maneuvers ranging from company-size units to combined Second Division, Force Troops, and Marine Air Wing units. These exercises involve the use of heavy equipment; however, heavy-tracked vehicles are permitted to cross the dunes only in restricted areas to protect the ecologically sensitive coastal barrier dunes.

The aquatic ecosystems on MCB Camp Lejeune are important as a freshwater and marine fisheries resource, as a habitat for local and migratory bird species, as a recreational resource, as a habitat for local migratory bird species, as a recreational resource for pleasure boating, and as a commercial resource for year-round barge traffic. The aquatic ecosystem contains a wide variety of fresh and salt water fish species, local shore bird species, and migratory bird species.

MCB Camp Lejeune is also used for training exercises involving the use of large numbers of tracked and wheeled vehicles and live ordnance. The use of these items are restricted and carefully controlled to protect human health and safety and the environment.

According to the master plan, there are two major corridors of developable land in the area of MCB Camp Lejeune. These extend south from New Bern along U.S. 17 and U.S. 58, and from Swansboro northwest to Jacksonville and Richlands along Routes 24 and 258. The principal economic base of the area is MCB Camp Lejeune and associated military activities. More than 46,000 military personnel are stationed at the base and more than 110,000 people are either employed or are eligible for support (ES&E, 1990).

2.9 LAND USE AND POPULATION TRENDS OF ONSLOW COUNTY

During the past 10-year period, urbanization has rapidly increased in Onslow County. Residential development has flourished adjacent to all Base boundaries, except in areas where both adverse soil conditions limited the use of septic tank and central sewage treatment facilities were unavailable. The present military population of Camp Lejeune is approximately 40,928 active duty personnel. The military dependent community is in excess of 32,081 (monthly Camp Lejeune Area Population report, 30 Nov. 1985). About 36,086 of these personnel and dependents reside in Base housing units. The remaining personnel and dependents live off base and have had dramatic effects on the surrounding area. An additional 4,412 civilian employees perform facilities management and support functions. The population of Onslow County has grown from 17,939 in 1940 (Federal Census, 1940), prior to the formation of the Base, to its present population of 121,350 (Office of State Budget and Management Report, 27 Sept. 1985). The base, its personnel, and its related activities are an integral part of the local area and its social, economic, and political climate (Camp Lejeune, North Carolina, 1987).

2.10 WEATHER AND CLIMATE

Camp Lejeune has a mild climate. Typically, summers are hot and humid and winters are cool with some subfreezing cold spells. An occasional accumulation of snow occurs but rarely persists for more than a few hours. The annual average precipitation is 55.96 inches with the mean temperature being about 60.9°F. The prevailing wind direction is from the southwest; however, sea breezes are a regular occurrence along the coastline. The mild climate and moderating effects of ocean currents provide a long growing season typically in excess of 230 days (Camp Lejeune, North Carolina, 1987).

2.11 UTILITIES

The source for all potable water for the base is groundwater from wells within the Camp Lejeune boundaries. Wastewater treatment plants are located on Camp Lejeune, and discharges are directed into the New River Estuary or tributary streams and into the Intracoastal Waterway. Carolina Power and Light provides electrical power. Commercial telephone trunk connections are to the Carolina Telephone and Telegraph Company facilities.

Camp Lejeune Water Wells

There are 95 water wells at the Base, of which 77 are operational and are scheduled to remain in service. The other wells were either scheduled to be replaced, repaired, or are out of service. Additionally, many other wells are to be completed in the near future, including 20 wells involved in the program to expand the Holcomb Boulevard Treatment Plant. Also there are many wells throughout the installation that have been removed from service for various reasons. Operational wells were of the following depth and yield:

System	Average Depth (feet)	Average Yield (gpm)
Hadnot Point	177	177
Holcomb Boulevard	240	236
Tarawa Terrace	95	109
Montford Point	98	121
MCAS	207	150
Camp Geiger	113	130
Rifle Range	138	184
Courthouse Bay	118	174
Oslow Beach	108	213

The shallow wells at Tarawa Terrace and Montford Point provide the lower yield; furthermore, the quality of water is not good because of iron content and hardness. The hardness is virtually due to calcium bicarbonate. The most recently constructed wells at Camp Lejeune Military Reservation characteristically are deeper wells with better water quality. The 20 wells proposed for expansion of Holcomb Boulevard Treatment Plant are spaced about 2,000 feet apart to minimize overlapping drawdown effects between the wells (Camp Lejeune, North Carolina, 1987).

2.12 SITE LOCATION MAPS

The Site Location and Proposed Sample Location maps provided for each site are based on conceptual site layout and maps provided by MCAS Camp Lejeune. The maps are not to exact scale and are to be used for general information only. Detailed scale maps will be provided upon completion of the field tasks.

Topographic lines on the above-referenced maps are approximate and depict ground surface elevations measured in feet above mean sea level (msl).

Most creeks and streams are shown in their approximate location. Those waterways that are not labeled are un-named streams that are not regionally important or are seasonal in nature.

3.0 SITE 7: TARAWA TERRACE DUMP

3.1 SITE BACKGROUND AND PHYSICAL SETTING

Tarawa Terrace Dump is a landfill located east of the sewage treatment plant between Tarawa Boulevard and Northeast Creek (PDWM coordinates 3, F4). Its size is estimated at 5 acres. The landfill was closed in 1972, but the years of operation are not known. As far as is known, no hazardous materials were disposed of in this facility. Only construction debris, sewage treatment plant filter media, and household trash are known to have been disposed. The location of the site is shown in Figure 3-1, with the boundaries being approximated pending further investigation.

3.2 INITIAL INVESTIGATION

No previous field activities have been conducted at this site.

3.3 PROPOSED SCOPE OF WORK

The field investigation for this site is intended to determine whether the potential for an environmental contamination problem exists. Figure 3-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

3.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed at all proposed boring and monitoring well locations using an electromagnetometer. This task is required to minimize drilling through buried drums or other metalic debris.

3.3.2 Groundwater

Three shallow monitoring wells are proposed for this site at the approximate locations shown in Figure 3-2. Final sample locations will be determined in the field by the project hydrogeologist, pending the completion of a surface geophysical survey. Although the groundwater flow direction is not known, it is assumed that the water flows toward Northeast Creek. Therefore, two downgradient wells are proposed for the southern side of the site, and one upgradient well is proposed for the northern side of the site. It is intended that these wells will be approximately 25 feet deep and will be constructed in such a manner that their screens intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one directly above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

3.3.3 Soil

Five 15-foot-deep soil borings are proposed for this site. Two soil samples from each boring will be sent to the laboratory for chemical analysis. Proposed sample collection depths are at or near the ground surface and in the zone directly above the water table. Preliminary locations of the borings are shown on Figure 3-2. Final locations will be determined in the field after the geophysical survey and will be located in or near suspected areas of contamination.

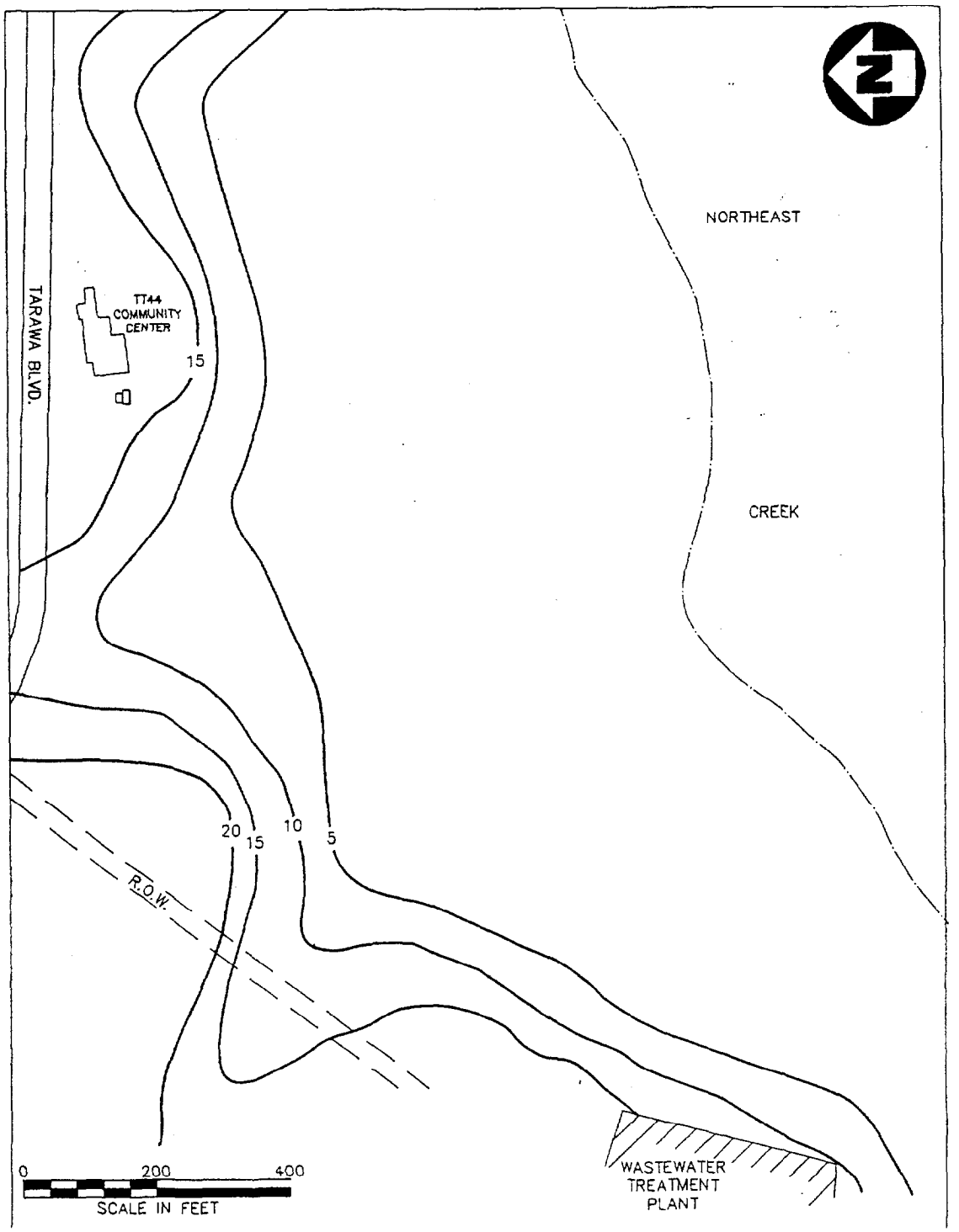

FIGURE 3-1
SITE 7: TARAWA TERRACE DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

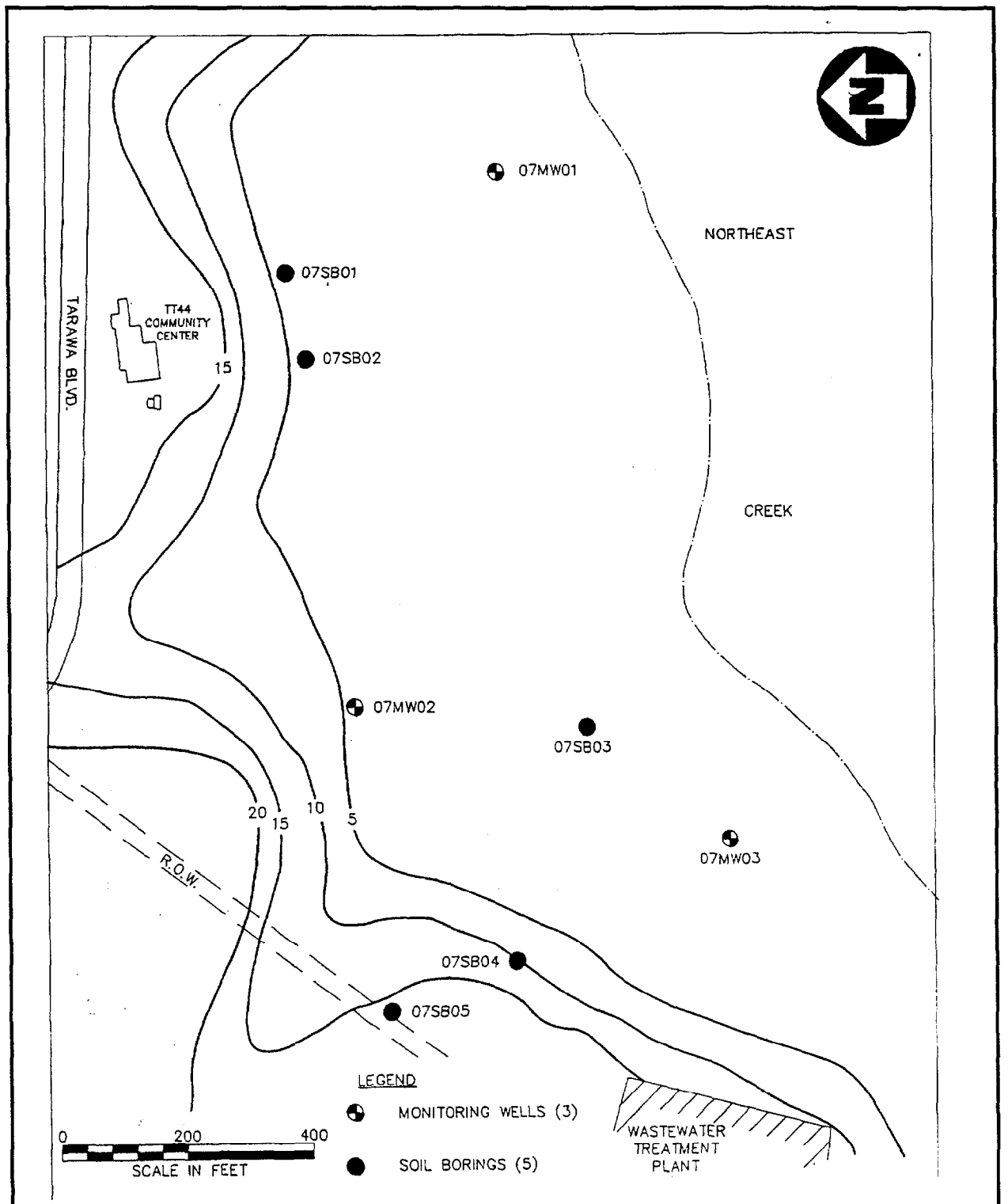

FIGURE 3-2
SAMPLE LOCATIONS
SITE 7: TARAWA TERRACE DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

3.3.4 Analysis

A complete analytical scheme is recommended for this site due to the uncertainty surrounding waste disposal activities. Therefore, all samples will be analyzed for the full Target Compound List (TCL) of organics and inorganics, including cyanide. The list of specific TCL compounds of this document is presented in Appendix A.

3.3.5 Surveying

Upon completion of the field operations, monitoring well and soil boring locations and elevations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

3.3.6 Summary

Table 3-1 presents a summary of the field investigation for this site. Additional details on the field activities are presented in Volume I of the Sampling and Analysis Plan.

TABLE 3-1

SUMMARY OF FIELD INVESTIGATION
SITE 7: TARAWA TERRACE DUMP
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect one water sample from each well • Analyze all for - TCL organics - TCL inorganics, cyanide	• Drill five 15-foot borings* • Collect 2 samples from each boring • Collect 2 samples from each monitoring well boring • Analyze all for - TCL organics - TCL inorganics, cyanide	• None

*Locations contingent upon results of geophysical survey.

4.0 SITE 63: VERONA LOOP DUMP

4.1 SITE BACKGROUND AND PHYSICAL SETTING

The Verona Loop Dump is located at PWDM coordinates 14, H5. Its size is estimated to be between 3 and 4 acres. It is believed that bivouac wastes were disposed of at this site, but the years of operation are unknown. It is not believed that hazardous waste was disposed at this site. The location of the site is shown in Figure 4-1, with the boundaries being approximated pending further investigation.

4.2 INITIAL INVESTIGATIONS

No previous field activities have been conducted at this site.

4.3 PROPOSED SCOPE OF WORK

The scope of work proposed for this site is designed to allow determination of whether hazardous materials may have been disposed of in the landfill. The number and placement of wells and soil borings is designed to maximize the chances for detecting hazardous materials if they are present. The analytical program is complete and does not focus on any known indicator chemicals. Figure 4-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

4.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed at all proposed boring and monitoring well locations using an electromagnetometer. This task is required to minimize drilling through buried drums or other metalic debris.

4.3.2 Groundwater

Three monitoring wells are proposed for this site. Groundwater flow direction is not known at this time; however, it is assumed the groundwater flows northeastward toward the New River. Two of the monitoring wells are proposed for the assumed downgradient direction and one for an upgradient location, as shown in Figure 4-2. It is also assumed that each well will be approximately 25 feet deep, and a screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well.

4.3.3 Soil

Six soil borings will be drilled and sampled at this site. The borings are located in order to maximize coverage of the site, as shown in Figure 4-2. Final locations will be selected pending the results of the geophysical survey. Each boring will be approximately 15 feet deep, and two soil samples will be collected from each boring for chemical analysis. The samples are proposed for the near surface interval as well as that immediately above the water table.

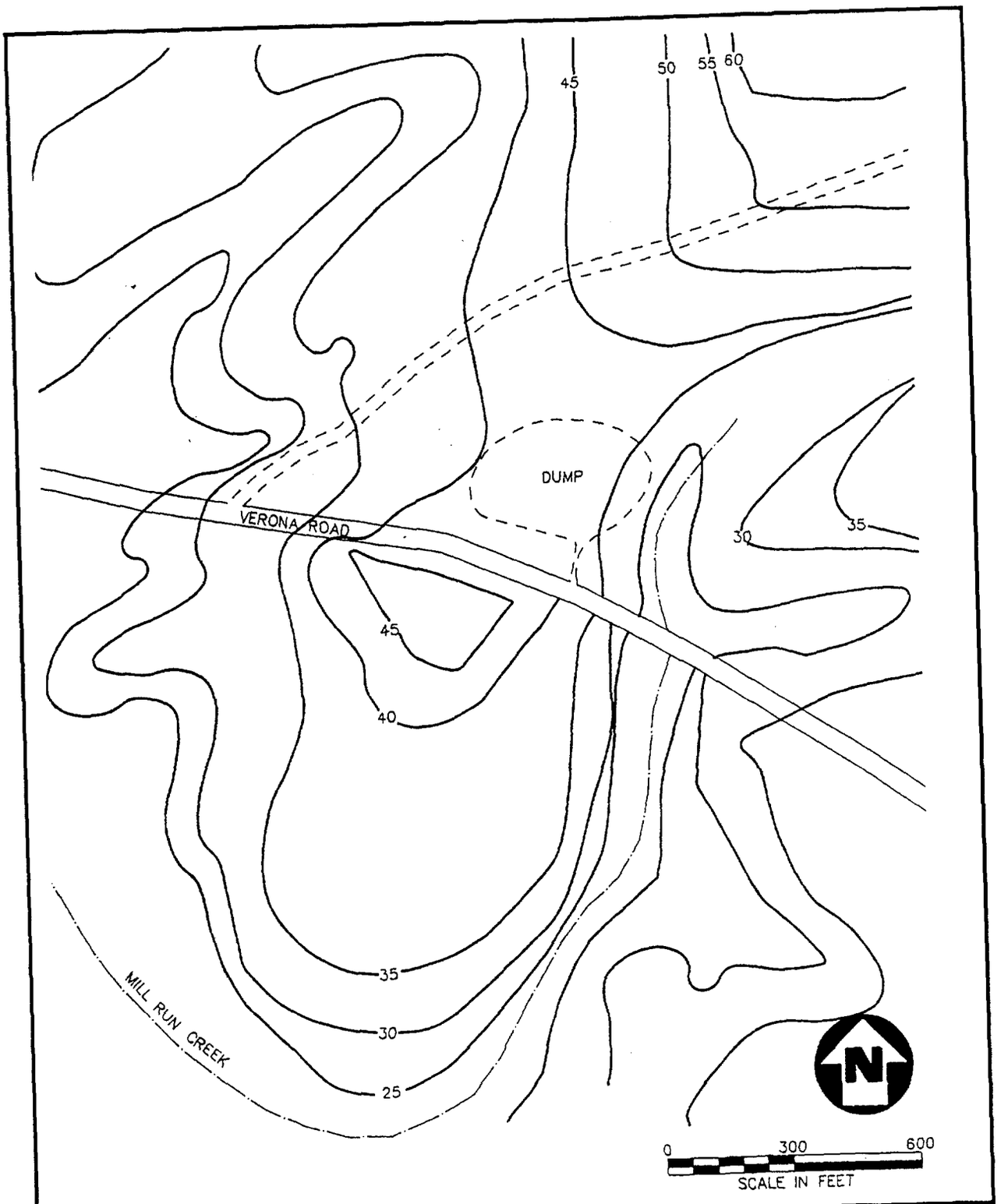

FIGURE 4-1
SITE 63: VERONA LOOP DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

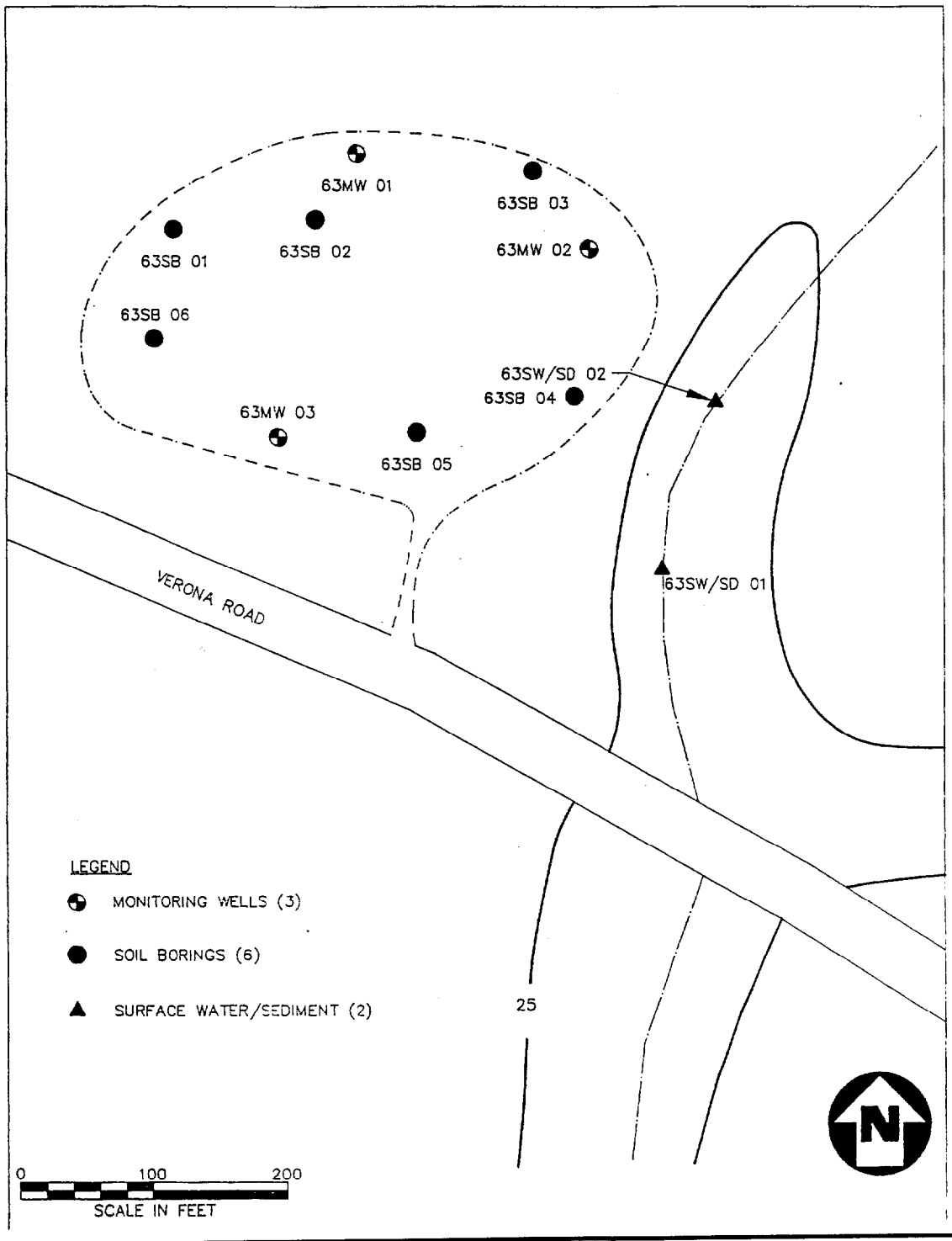

FIGURE 4-2
SAMPLE LOCATIONS
SITE 63: VERONA LOOP DUMP
CAMP LEJEUENE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

4.3.4 Surface Water/Sediment

It is proposed that two sediment samples be collected from a small creek to the east of the site. Surface water samples will be collected from the same locations as the sediment samples. Approximate locations are shown in Figure 4-2.

4.3.5 Analysis

Because no details exist for this site regarding the types and amounts of waste disposed of and because the potential exists for historic disposal of hazardous wastes, the full Target Compound List (TCL) (organics, inorganics, and cyanide) is proposed for every sample at this site. This list of chemicals, located in Appendix A of this document, is complete and provides adequate detail to determine whether a problem exists at the site and what the potential public health impacts might be.

4.3.6 Surveying

When the field operations have been completed, monitoring well locations and elevations, soil boring locations, and surface water/sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

4.3.7 Summary

Table 4-1 presents a summary of the proposed field investigation tasks for this site. Additional details regarding all these activities are presented in Volume I of the Sampling and Analysis Plan.

TABLE 4-1

SUMMARY OF FIELD INVESTIGATION
SITE 63: VERONA LOOP DUMP
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells • Collect one water sample from each well • Analyze all for - TCL organics - TCL inorganics, cyanide	• Drill six 15-foot soil borings • Collect 2 samples from each boring • Collect 2 samples from each monitoring well boring • Analyze all for - TCL organics - TCL inorganics, cyanide	• Collect 2 surface water/sediment samples from a creek east of site • Analyze all for - TCL organics - TCL inorganics, cyanide

*Locations contingent upon results of geophysical survey.

5.0 SITE 54: CRASH CREW BURN PIT

5.1 SITE BACKGROUND AND PHYSICAL SETTING

The Crash Crew fire training pit is a 1.5-acre site within the boundaries of MCAS New River. It is located adjacent to the southwest end of Runway 5-23 near Structure 3614 (PWDM coordinates 23, O24-25/P24-25). A map of the site, which includes the locations of samples collected by previous contractors, is presented in Figure 5-1.

An underground storage tank has been installed at this site within the last few years. It is located approximately 100 feet to the northwest of the burn pit. The area of concern is believed to have been used in the mid-1950s for crash crew training. Contaminated fuels (principally JP-type and possibly leaded fuels) and waste oils were burned during the training exercises. Originally the training was conducted on the ground surface, and the area was surrounded by a berm. Later, a burn pit was used, which was lined in or around 1975.

Figures 5-2 and 5-3 present geological cross-sections that were prepared by ES&E (1990). The sections show that the site is underlain by silty sand and silty gravelly sand, with discontinuous layers of coarse sand at depths of up to 10 feet. The groundwater contour map, Figure 5-4 (ES&E, 1990) shows that the shallow groundwater flows toward the drainage ditch along the southwest side of the site, with a gradient of approximately 0.037 ft/ft.

During construction of a runway in the area, 54MW1 was removed. Therefore, monitoring well 54MW1 no longer exists.

5.2 INITIAL EVALUATION

5.2.1 Groundwater

One shallow monitoring well was installed during the initial site investigation in 1984. Groundwater samples from the shallow well (54GW1) and Supply Well 5009 were collected and analyzed for the following parameters:

- Cadmium
- Total chromium
- Lead
- Oil and grease
- Volatile organics (VOCs)
- Total phenols

The July 1984 results indicate that chromium, oil and grease, and phenols were detected in well 54GW1, but only phenols were detected in Supply Well 5009. No VOCs were detected in either of the 1984 samples.

Two additional shallow monitoring wells (54GW2 and 54GW3) were installed during the 1986 investigation by ES&E. Well 54GW2 is located upgradient of the burn pit. Samples were collected from these two wells and the existing well, and analyzed for the following target compounds:

- Cadmium
- Total chromium
- Hexavalent chromium
- Lead

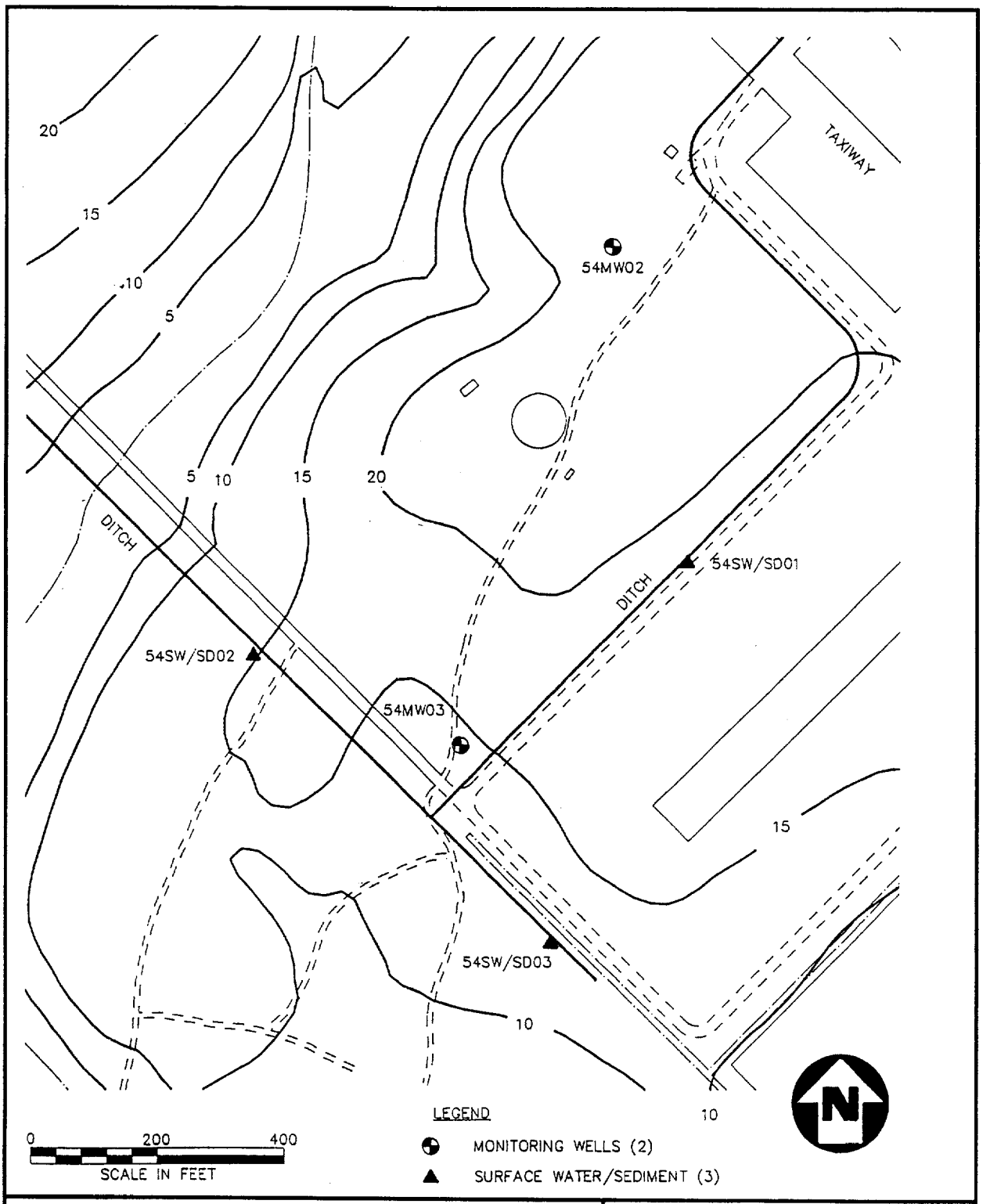

FIGURE 5-1
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

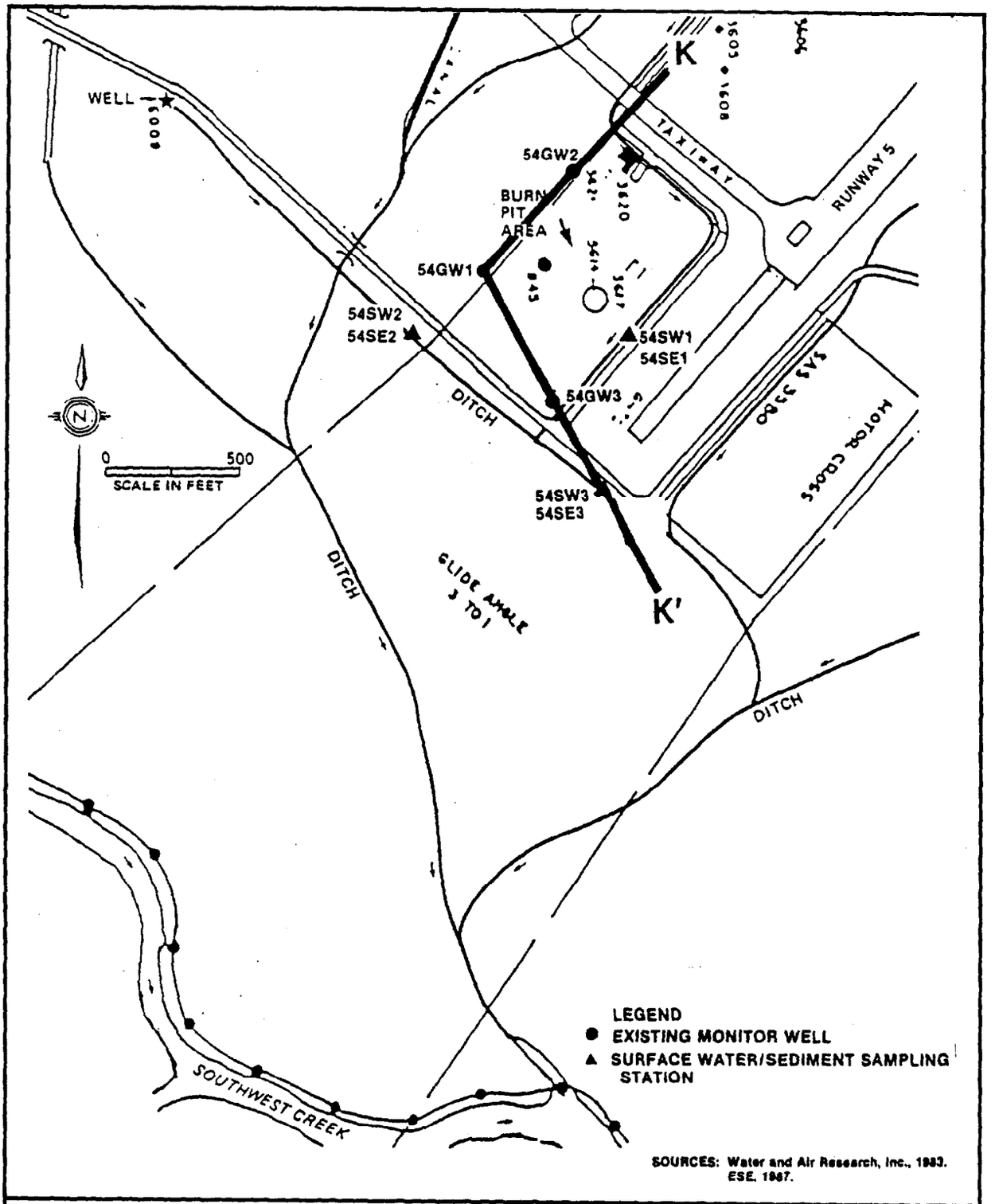

FIGURE 5-2*
GEOLOGIC CROSS SECTION LOCATION
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE MILITARY RESERVATION
SOURCE: ES&E, 1990
*54MW1 no longer exists.

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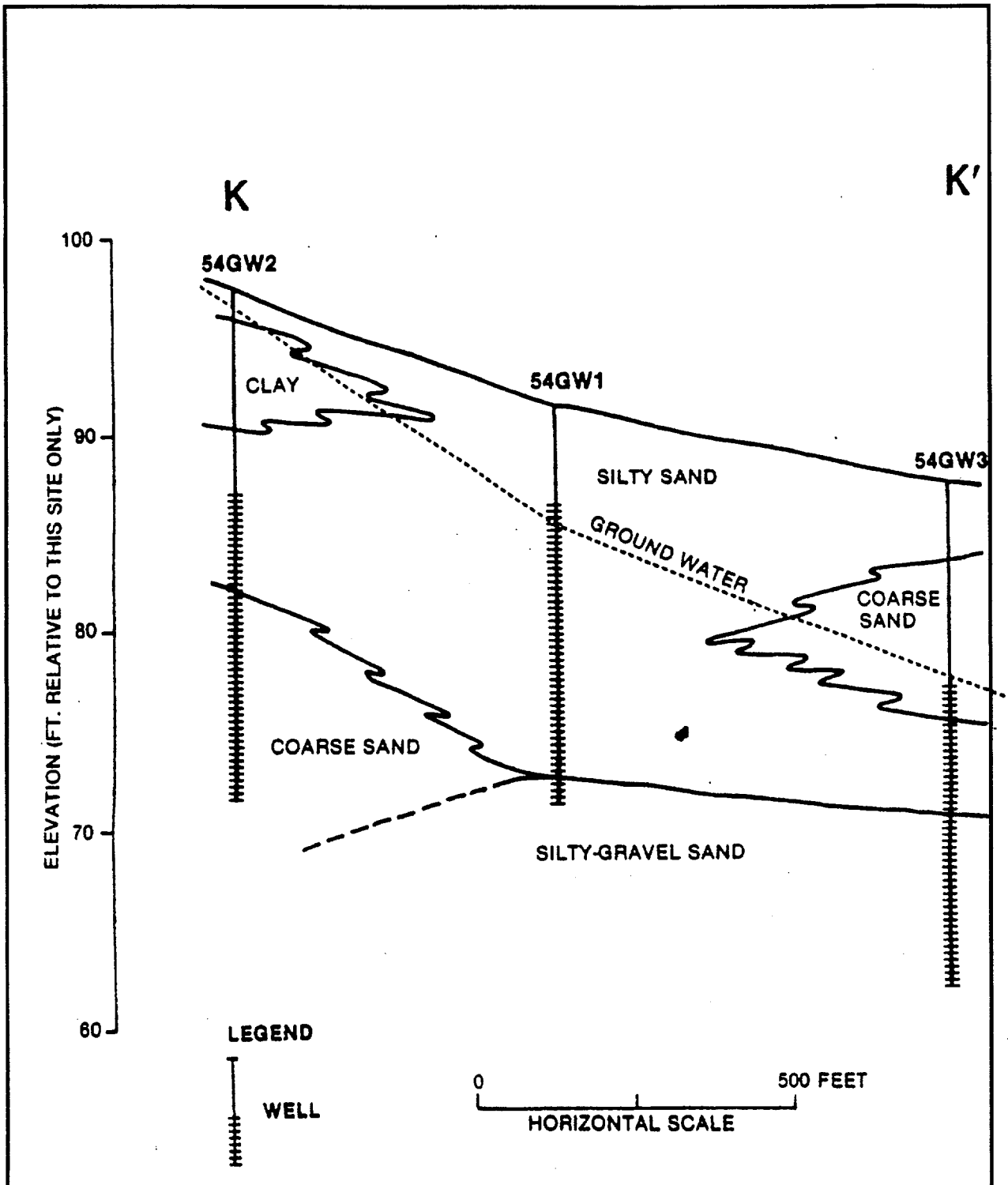

FIGURE 5-3*
GEOLOGIC CROSS SECTION
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE MILITARY RESERVATION
SOURCE: ES&E, 1990
*54MW1 no longer exists.

NUS CORPORATION
A Halliburton Company

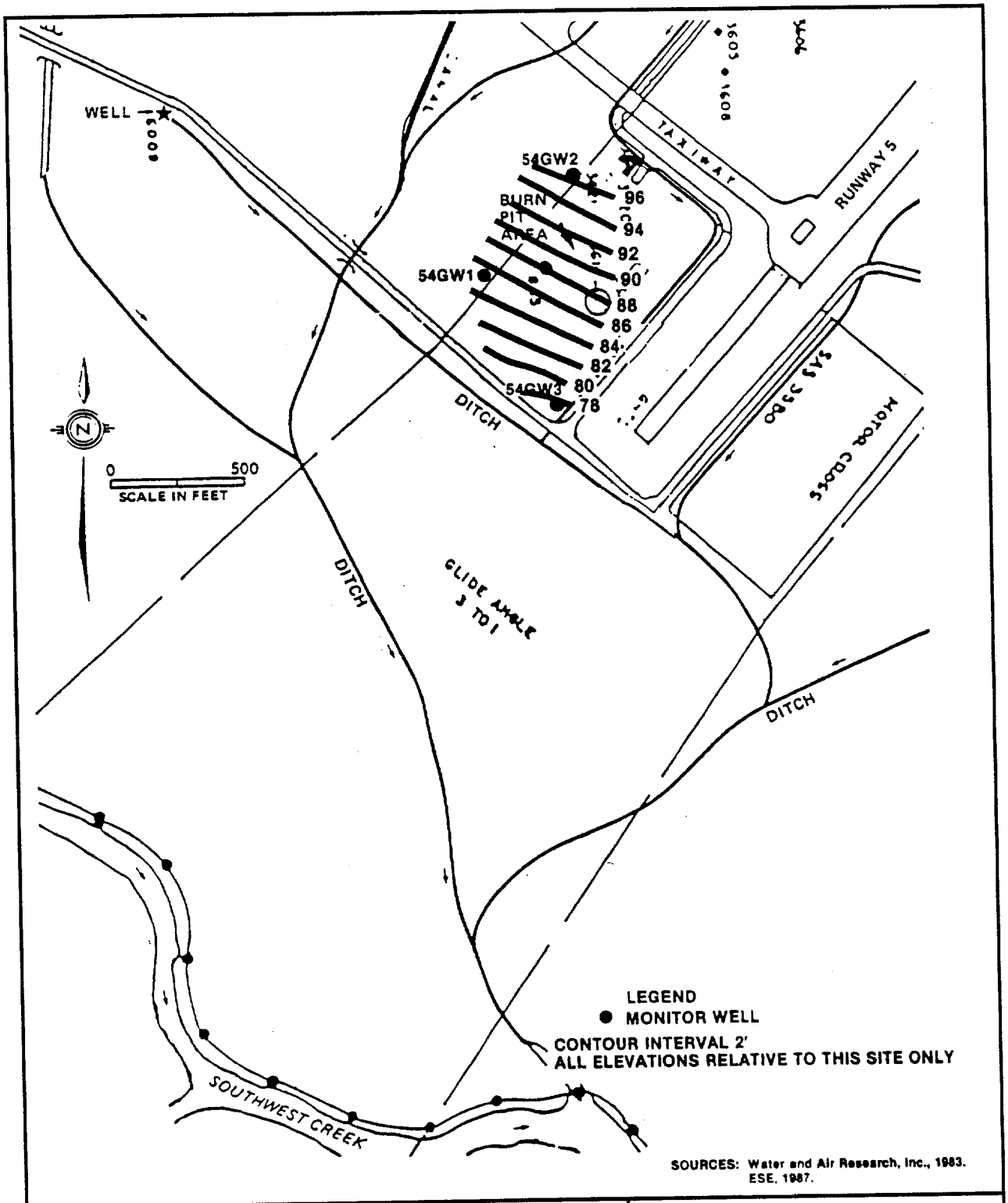

FIGURE 5-4*
GROUND WATER CONTOUR MAP, SHALLOW AQUIFER
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE MILITARY RESERVATION
SOURCE: ES&E, 1990
*54MW1 no longer esists.

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- Oil and grease
- Volatile organics
- Total phenols
- Xylenes
- Methyl isobutyl ketone (2-butanone)
- Ethylene dibromide

Table 5-1 presents a summary of the 1984, 1986, and 1987 results for all analytes that were detected at concentrations greater than the detection limits.

The December 1986 and March 1987 results indicate that the samples collected from the upgradient well (54GW2) contained both trivalent and hexavalent chromium. The sample collected in March 1987 also contained a quantifiable amount of lead (27 µg/L), which is below North Carolina's Groundwater Standard but above the proposed Maximum Contaminant Level (MCL) of 5 µg/L. One of the samples collected from the downgradient well (54GW3) also contained trivalent and hexavalent chromium. Five of the samples contained oil and grease at concentrations ranging from 1,000 to 3,000 µg/L.

The groundwater sample collected from well 54GW1 in 1986 contained the same compounds as in the 1984 sample effort, as follows:

- Total chromium
- Oil and grease
- Phenols

None of the groundwater samples collected in 1986/1987 contained volatile organic compounds VOCs.

Since the last samples were collected, one of the monitoring wells (54GW1) has been removed. This probably occurred during either the extension of a nearby runway or the installation of an onsite underground storage tank. The installation of this runway may have impacted the hydrogeological characteristics identified in Figures 5-2, 5-3 and 5-4.

5.2.2 Surface Water/Sediment

Three surface water and sediment sample pairs were collected in 1986 from the drainage ditch on the southeastern and southwestern sides of the burn pit (see Figure 5-1). The surface water samples were analyzed for the same parameters as the groundwater samples. The sediment samples were analyzed for the following parameters:

- Cadmium
- Total chromium
- Hexavalent chromium
- Lead
- Oil and grease
- Total phenols
- Ethylene dibromide

The analytical results indicated the surface water sample collected from the southeastern ditch (54SW1) contained phenols at a concentration of 3 µg/L. No other target analytes were detected in any of the surface water samples.

The analytical results for the sediment samples are presented in Table 5-2. All three samples contained chromium, oil and grease, and total phenols. The two samples closest to the site also

TABLE 5-1*

DETECTED TARGET ANALYSES - GROUNDWATER SAMPLES
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE, NORTH CAROLINA

Parameter	Sample/Date								
	54GW1 07/16/84	54GW1 12/11/86	54SU5009 07/16/84	54GW2 12/10/86	54GW2 03/05/87	54GW3 12/10/86	54GW3 03/05/87	NC GW Standards	Federal Standards
Chromium	60	10.7	<8	67.9	28	23.9	32	50	100
Chromium(+ 6)	NA	<10	NA	14.6	45.9	<10	12.1	50**	None**
Lead	<40	<27	<40	<27	<27	<27	<27	50	5***
Oil & Grease	1,000	3,000	<900	<300	1,000	2,000	2,000	None	None
Phenols	3	4	2	<2	<2	6	<2	None	None

All units in micrograms per liter (µg/L); this approximates parts per billion (ppb).

Source: ES&E, 1990.

*Full ARAR's will be incorported in the SI report.

**For total chromium.

***Proposed Level.

TABLE 5-2*

DETECTED TARGET ANALYSES - SEDIMENT SAMPLES
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE, NORTH CAROLINA

Parameter	Sample/Date		
	54SE1 12/10/86	54SE2 12/10/86	54SE3 12/10/86
Chromium	19.3	6.45	6.48
Lead	28.2.	9.36	<6.73
Oil & Grease	998	884	1,560
Phenols	0.443	0.334	2.01

All units in micrograms per liter (µg/L), this approximates parts per billion (ppb).
Note: There are no North Carolina soil standards.

Source: ES&E, 1990.

*Full ARARs will be identified in the SI report.

contained lead. None of the samples contained VOCs. Sample 54SE1 contained the highest concentrations of total chromium (19.3 mg/kg) and lead (28.2 mg/kg).

5.2.3 Soils

During the 1984 investigation, nine soil borings were hand-augured around the burn pit area to visually determine whether the soil was contaminated. The borings from the area southeast of the burn pit released a fuel-like odor. In addition, fuel and oil products have been observed seeping from the ground into the drainage ditches during periods of heavy rainfall.

5.3 PROPOSED SCOPE OF WORK

This section outlines the scope of the work to be performed at this site. As described in Section 1.0, the intent of this investigation is to collect sufficient data to support a risk assessment to determine whether the site presents a risk to either human health or the environment. To do so, it is necessary to better characterize the site as it exists today.

The scope of work for the previous investigations was limited. Although it is known that fuels and possibly miscellaneous wastes were burned at the site, no fuel constituents were detected in the groundwater. This may be due either to the high detection limits in the laboratory or to the locations of the wells. In addition, no soil samples were ever collected for chemical analysis.

Based on the known and suspected contaminants at the site, certain assumptions can be made regarding their environmental distribution. Volatile organics (specifically benzene, toluene, ethylbenzene, and xylenes or BTEX) are relatively soluble and do not preferentially adsorb to organic carbon in the soil, and would therefore be expected in the groundwater and/or in subsurface soils near the water table.

Free product fuels that are spilled directly on the ground or that are flushed through with fluids used to extinguish flames would eventually migrate downward through the soil column to the water table. Fuel constituents are commonly present in soils near the water table, where they are retained to some degree as the water table fluctuates. These contaminants will, to some extent, go back into solution as the water table rises.

Metals, on the other hand, are generally less mobile, and their behavior in the environment cannot be accurately predicted. However, it can be generally concluded that metals tend to adhere to soil particles instead of moving as a solute. Therefore, inorganic contaminants (those present at concentrations that exceed background values) would primarily migrate off site as eroded soil particles.

Metals were detected in the groundwater samples in both the 1984 and 1986 investigations (ES&E, 1990), but they may not actually have been transported downward from the surface. Because these samples were unfiltered, the metals observed are more likely to be associated with the soil matrix itself rather than with contamination originating at the ground surface.

It is possible that waste oils containing polychlorinated biphenyls (PCBs) could also have been burned at this facility; therefore, PCBs could be a concern. PCBs are relatively immobile in the environment due to their high organic carbon partition coefficients. This factor indicates that the PCBs preferentially bind to soils and are unlikely to migrate through the soil matrix to the groundwater. The scope of work is discussed in detail below.

5.3.1 Groundwater

One new monitoring well will be installed southwest of the burn pit. It is intended that this will serve the purpose of providing triangulation of the water table surface and is assumed to be downgradient of the burn pit. The well will be constructed so that the screen intersects the water table. The proposed location of this well is shown in Figure 5-5.

Two soil samples will be collected for chemical analysis during the drilling activity. These samples will be collected from the well boring, one near the ground surface and one above the water table. After installation is complete, a groundwater sample will be collected from the new well and the two existing wells.

5.3.2 Surface Water/Sediment

In addition to resampling in the approximate locations of the three surface water/sediment sample pairs, two additional sample locations are proposed. The approximate locations of these samples are also shown in Figure 5-5. The intent of this task is to define the current site conditions, as well as to delineate the areas thought to be affected by releases from the site.

5.3.3 Soils

No soil samples were collected for chemical analysis during the previous investigations at this site. Therefore two 15-foot-deep soil borings are proposed in addition to that planned for well installation. The locations of the borings, as shown in Figure 5-5, were selected to provide some definition of the lateral and vertical extent of contamination. As with the well boring, two soil samples are planned for each of these borings from the near-surface and from above the water table.

5.3.4 Analysis

All samples collected from Site 54 will be analyzed for the following parameters:

- Benzene
- Toluene
- Ethylbenzene
- Total xylenes
- Total petroleum hydrocarbons
- Polychlorinated biphenyls (PCBs)
- Target Compound List (TCL) metals, including cyanide
- Hexavalent chromium

The rationale for selection of these chemicals follows. Benzene, toluene, ethylbenzene, and xylenes are chemicals that are readily used to determine whether a matrix could contain fuel-type products. These analytes are a specialized subset of the full Target Compound List volatiles and are basically indicator chemicals with a wide range of toxicity/carcinogenicity for risk assessment purposes.

Total petroleum hydrocarbons, although a nonspecific group of compounds, are a good indicator of the possible presence of contaminants associated with fuel products. North Carolina has established an action level for TPH. Soil clean-up between 10 and 100 ppm will be determined using the North Carolina "Guidelines for Remediation of Soil Contaminated by Petroleum."

PCB samples are recommended for this site because it is possible that PCB-contaminated oils materials were burned at this site. Although unlikely to be found in the groundwater or dissolved in the surface water because of their low migration potential in soils, we are testing for PCBs in all samples at this site. Past experiences have shown PCBs to be present in fuel products floating on groundwater.

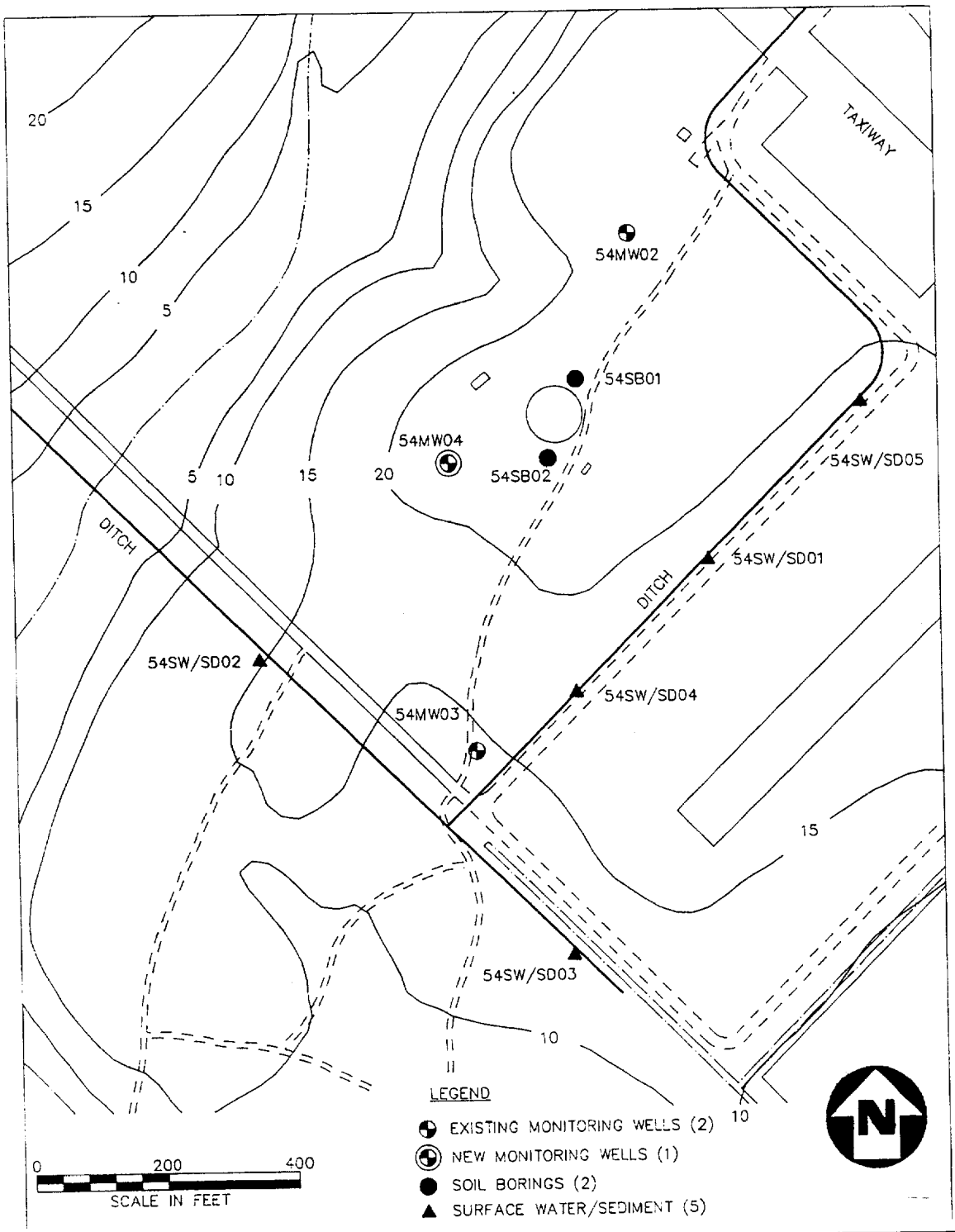

FIGURE 5-5
SAMPLE LOCATIONS
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE MILITARY RESERVATION

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TABLE 5-3

CONSTITUENTS IN WASTE OIL
CAMP LEJEUNE, NORTH CAROLINA
1981

Component	Concentration (mg/l)
Antimony	<0.02
Arsenic	<0.002
Barium	1.08
Beryllium	<0.005
Cadmium	1.88
Chromium	0.16
Copper	4.44
Lead	376.0
Mercury	<0.002
Nickel	0.36
Selenium	<0.002
Silver	0.16
Thallium	<0.1
Zinc	475.0
Toluene	0.012
1,1-Dichloroethane	0.004
Phenol	20

Source: Water and Air Research, Inc., 1983

The precise nature of the types of materials burned at this site is unknown. Because several toxic metals were detected in the previous work, it is proposed that analyses be performed for the full list (TCL metals) and cyanide. Table 5-3 shows the constituents found in waste oil at Camp Lejeune. From this table, it is clear that metals could be a concern at this site.

Hexavalent chromium was also selected for analysis during this investigation because it was previously detected. Hexavalent chromium is generally associated with paint or paint wastes. A source of this contaminant could be the "mock-up" of the downed plane/helicopter that is placed in the burn pit during use to simulate an actual crash.

5.3.5 Surveying

Upon completion of the field operations, monitoring well locations and elevations, soil boring locations, and surface water/sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

5.3.6 Summary

Table 5-4 presents a summary of the proposed scope of work for Site 54. Details on the field tasks are contained in Volume I of the Sampling and Analysis Plan.

TABLE 5-4

SUMMARY OF FIELD INVESTIGATION
SITE 54: CRASH CREW BURN PIT
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install one 25-foot well*	• Drill two 15-foot borings*	• Resample 3 previous locations
• Collect 1 water sample from 2 existing wells and 1 new well	• Collect 2 samples from each boring	• Collect samples from 2 new locations
• Analyze all for: - Benzene - Toluene - Ethylbenzene - Xylenes - Total petroleum hydrocarbons - TCL PCBs - TCL inorganics, cyanide - Hexavalent chromium	• Collect 2 samples from monitoring well boring • Analyze all for: - Benzene - Toluene - Ethylbenzene - Xylenes - Total petroleum hydrocarbons - TCL PCBs - TCL inorganics, cyanide - Hexavalent chromium	• Analyze all for: - Benzene - Toluene - Ethylbenzene - Xylenes - Total petroleum hydrocarbons - TCL PCBs - TCL inorganics, cyanide - Hexavalent chromium

* Locations contingent upon results of geophysical survey.

6.0 SITE 82: PINEY GREEN ROAD VOC AREA

6.1 SITE HISTORY AND PHYSICAL SETTING

The Piney Green Road VOC Area is a forested area between Lot 203 and Wallace Creek and appears to have been used as a disposal area at some point in the past. It is estimated to be 30 acres in size. There is visual evidence of debris piles and small depressions as identified by ES&E in the Site Summary Report, June 1990. This area is bounded on the northwest by Wallace Creek and is therefore a reasonable source of the observed VOCs in Wallace Creek. The area of investigation is shown in Figure 6-1.

6.2 INITIAL INVESTIGATION

In 1986, ES&E conducted a field investigation of IAS Site 6 which contains Storage Lots 201 and 203. These storage lots are known to have served as storage and waste disposal areas for DDT and transformers. During this same time period, the supply wells on the base were sampled. Trace levels of TCE and other chlorinated alkenes were detected in supply wells 651, 652, and 653. Supply well 652 is located further south and is not shown on Figure 6-1.

In 1986, a soil-gas survey was also performed in the vicinity of Site 6 along Piney Green Road. There was one isolated case of TCE detection southwest of Supply Well 652. Shallow monitoring wells were installed adjacent to the supply wells and the one isolated soil gas hit to determine whether there was a surface source of contamination. No contamination was found in any of the shallow wells; therefore, the source of contamination in the supply wells may be from outside the Wallace Creek area.

Figures 6-2 and 6-3 present a geological cross section that was developed by ES&E, Site Summary Report (1990) for the Site 6 area. The section shows the site to be underlain by silty sand, sand, and coarse sand. The surface of the shallow groundwater at this site lies within the silty sand at depths ranging from 2 to 15 feet below land surfaced. The groundwater contour map, Figure 6-4, indicates the groundwater flows toward Wallace Creek and Bearhead Creek at a gradient of approximately 0.009 ft/ft.

During the investigation of Site 6, surface water samples were collected from upstream and downstream locations in Wallace Creek, as shown in Figure 6-1. The samples were analyzed for VOCs and the i,p- and p,p-isomers of DDD, DDE, and DDT.

The surface water samples from Wallace Creek contained three VOCs: trichloroethene, vinyl chloride, and trans-1,2-dichloroethene, which were also detected in the supply wells. Table 6-1 provides the results of the analysis. Concentrations of theses constituents were higher in the downstream (6SW2) sample than in the upstream (6SW1).

Sediment samples were collected from the same locations as the surface water samples and analyzed for the same target compounds. Table 6-2 shows that the two Wallace Creek samples did not contain any target analytes above the method detection limits.

The source of VOCs in the surface water of Wallace Creek remains unknown. It appears unlikely that Lot 203, as currently defined, is the source of the three VOCs detected in the upstream and downstream water samples. The area described in Section 6.1 is the most probable source of contamination and the focus of this investigation.

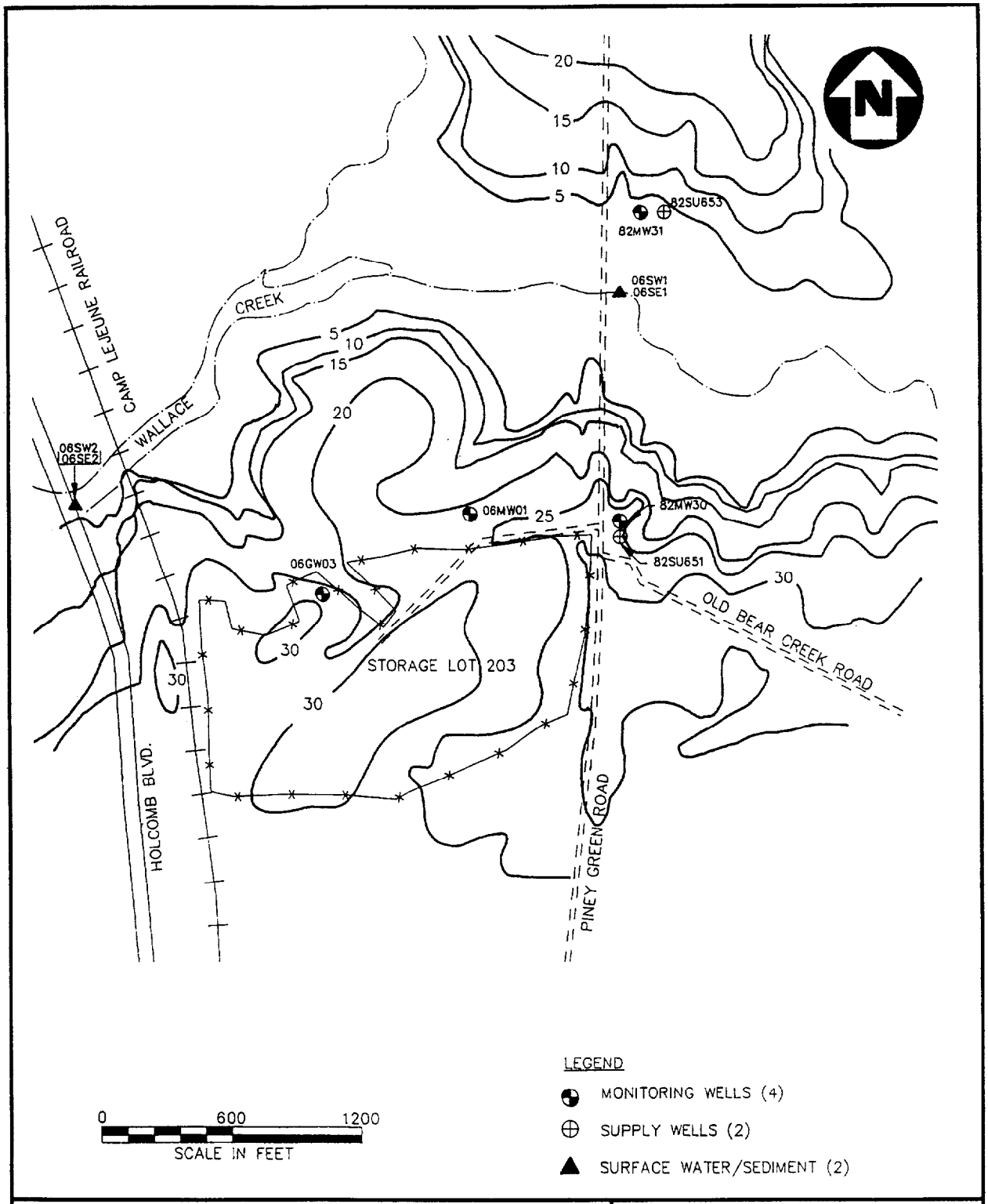

FIGURE 6-1
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE MILITARY RESERVATION

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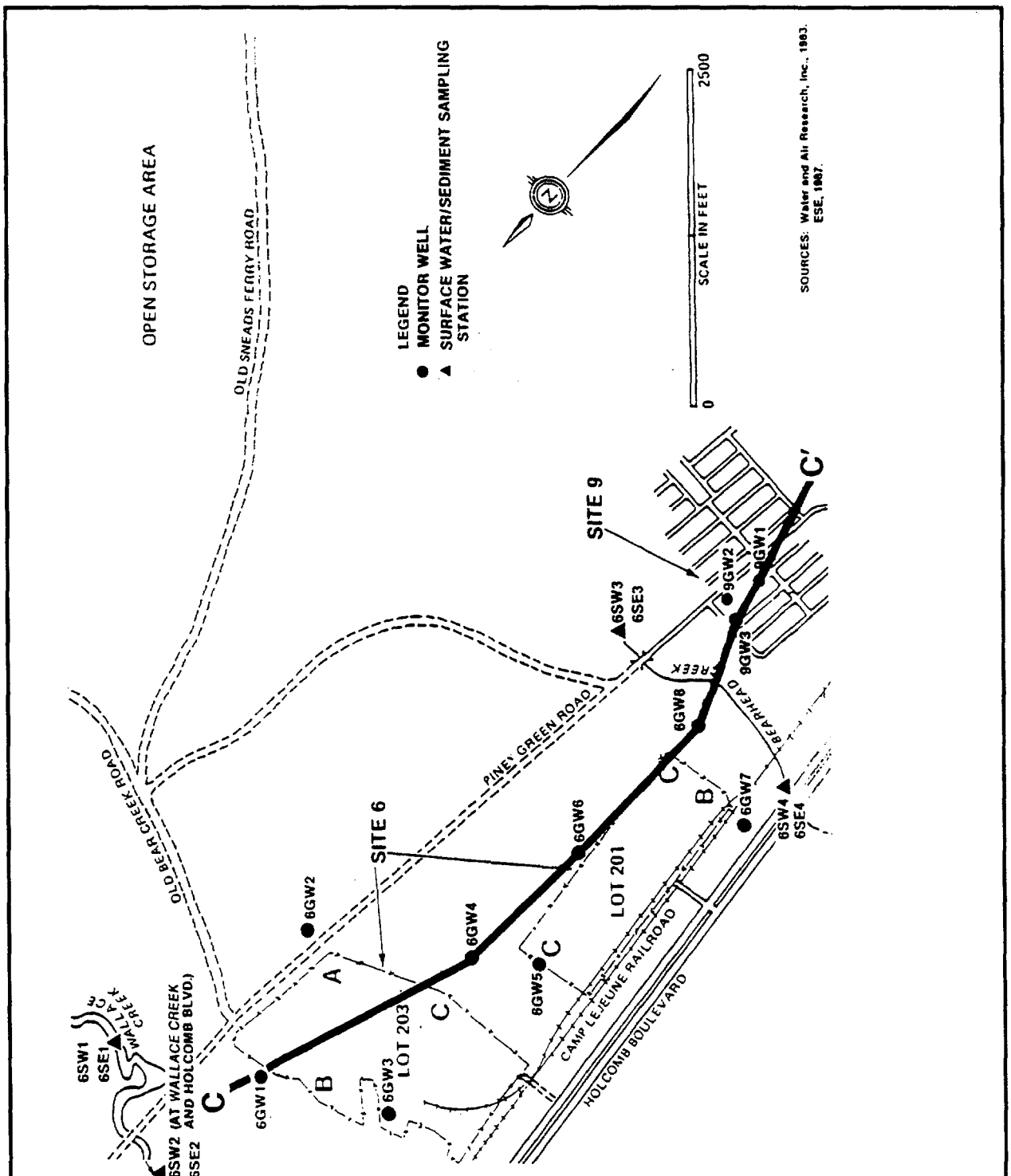

FIGURE 6-2
GEOLOGIC CROSS SECTION LOCATIONS, SITES 6 AND 9, STORAGE LOTS 201 AND 203 AND FIRE FIGHTING TRAINING PIT
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE MILITARY RESERVATION
SOURCE: ES&E, 1990

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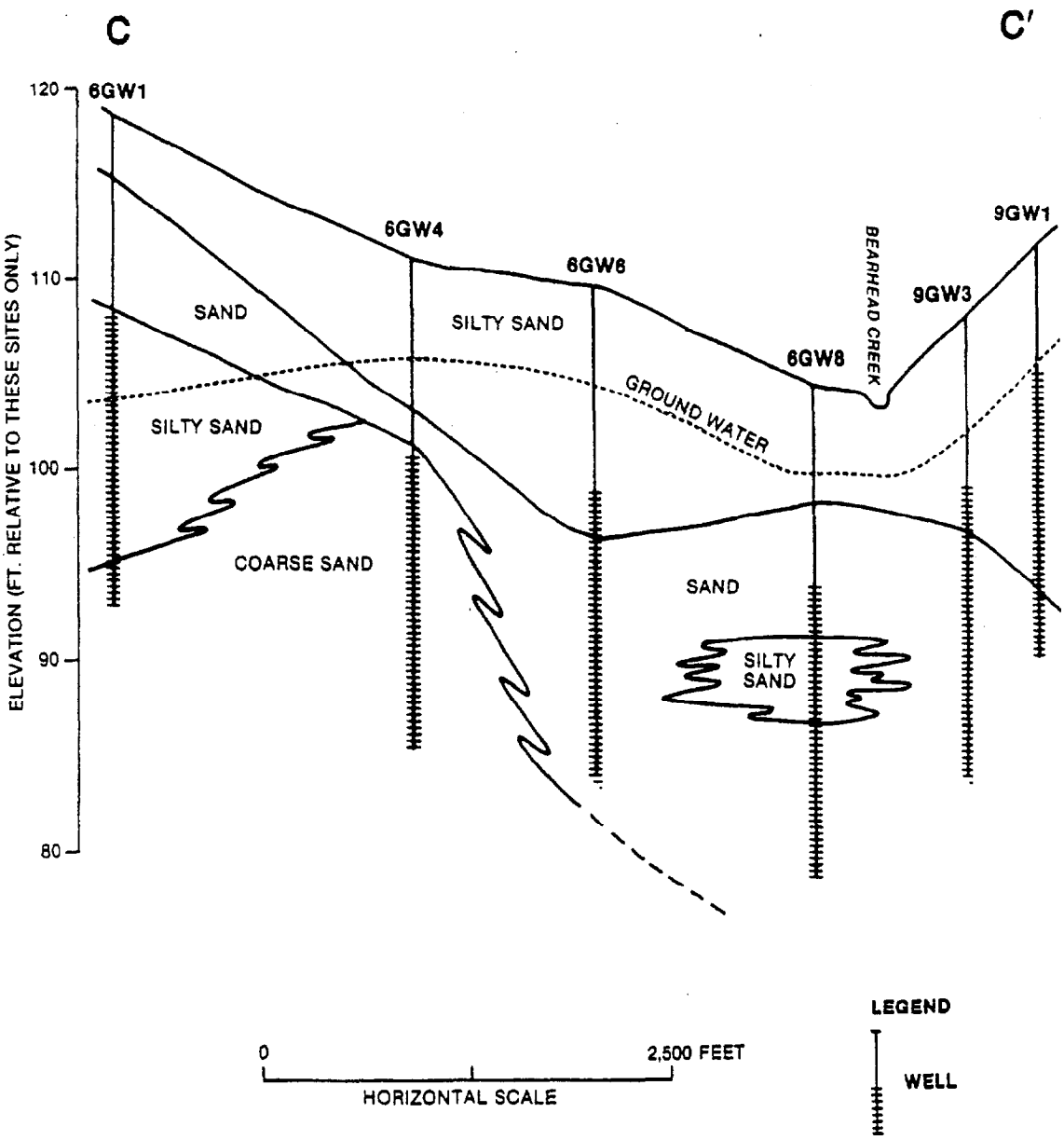

FIGURE 6-3
GEOLOGIC CROSS SECTIONS, SITES 6 AND 9, STORAGE LOTS 201 AND 203 AND FIRE FIGHTING TRAINING PIT
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE MILITARY RESERVATION
SOURCE: ES&E, 1990

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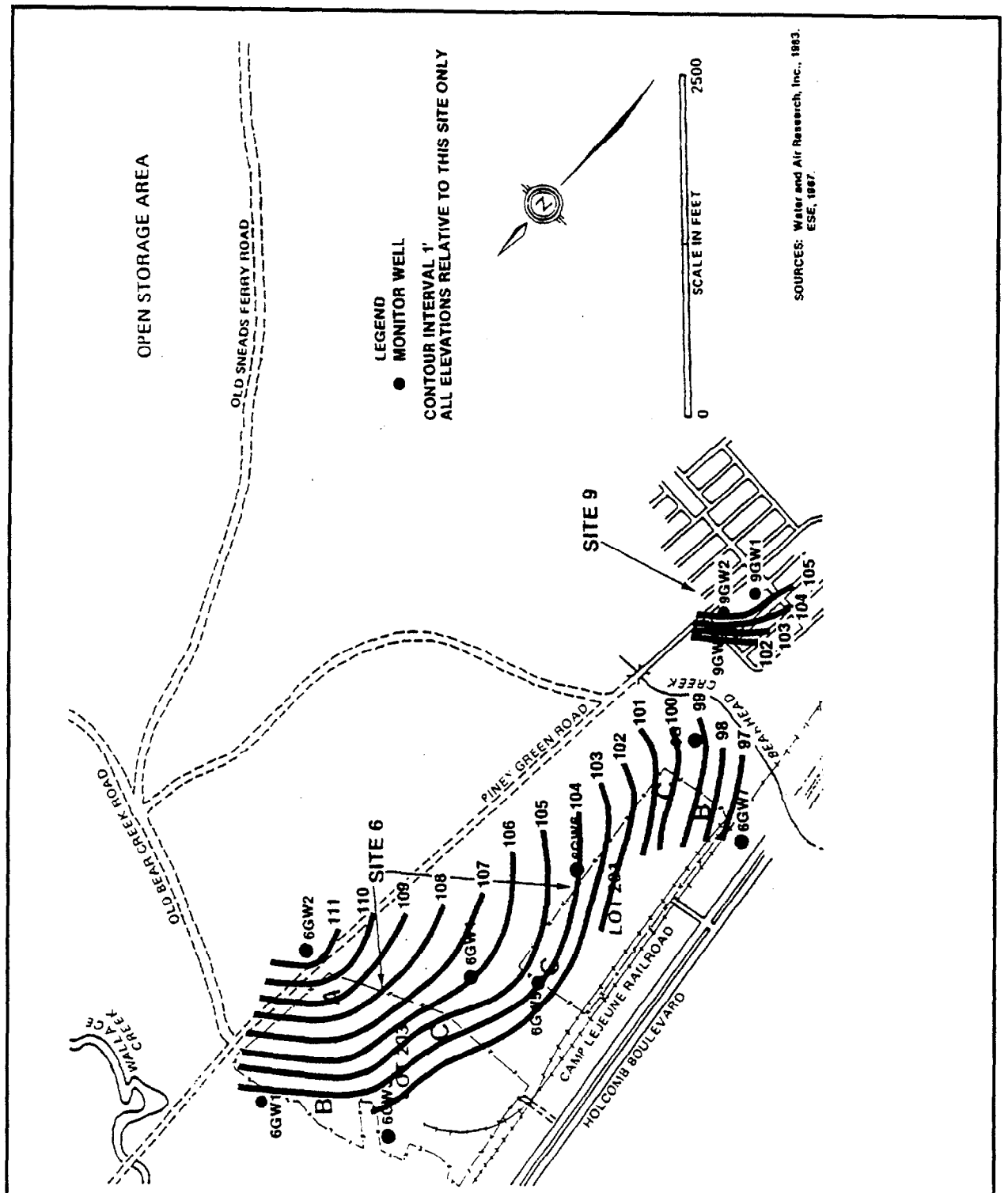

FIGURE 6-4
GROUNDWATER CONTOUR MAP--SHALLOW AQUIFER, SITES 6 AND 9--STORAGE LOTS 201 AND 203 AND FIRE FIGHTING TRAINING PIT
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE MILITARY RESERVATION

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TABLE 6-1*

SITE 6 STORAGE LOTS 201 AND 203
DETECTED TARGET ANALYTES
SURFACE WATER SAMPLES TAKEN 11/19/86

Parameter	6SW1	6SW2	NC SW Standards	Federal Standards
Trans-1,2-dichloroethene	6.4	35	None	100
Trichloroethene	<3.0	26	None	5
Vinyl chloride	1.9	3.6	None	3.6

Values reported are concentrations in micrograms per liter (µg/L); this approximates parts per billion (ppb).

Source: ES&E, 1990.

*Full ARARs will be incorporated in the SI report.

TABLE 6-2*

SITE 6 STORAGE LOTS 201 AND 203
DETECTED TARGET ANALYTES
SEDIMENT SAMPLES TAKEN 11/19/86

Parameter	6SE1	6SE2
DDE, PP'	<0.0142	<0.0137
DDT, PP'	<0.0711	<0.0685

Values reported are concentrations in micrograms per gram (µg/g); this approximates parts per million (ppb).

Note: There are no NC or Federal sediment standards.

Source: ES&E, 1990.

*Full ARARs will be incorporated in the SI report.

6.3 PROPOSED SCOPE OF WORK

The intent of the proposed field investigation is to identify potential source(s) of contamination in Wallace Creek. Although minimal contamination was discovered in Lot 203 in the previous investigation and no obvious sources were identified during the soil gas survey, the area between Lot 203 and Wallace Creek may be an area of concern. The area appears to have been disturbed, and no other potential source areas were identified during an extensive site reconnaissance.

The investigation will focus on the types of contaminants identified earlier, namely TCL volatile organics, pesticides, and PCBs. Although Lot 203 has been evaluated in the past, the area known as the Piney Green Road VOC Area itself is new. Figure 6-5 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

6.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed at all proposed boring and monitoring well locations using an electromagnetometer. This task is required to minimize the likelihood of drilling through buried drums or other metalic debris.

6.3.2 Groundwater

Three 25-foot-deep monitoring wells are planned for this site. The upgradient well is located near the bridge on Piney Green Road, which is the area of the creek found to contain volatile organics in 1986. One well will be located downstream toward Holcomb Boulevard. The third well is proposed for the approximate center of the site. Proposed well locations are shown in Figure 6-5.

Each of the new wells will be constructed with the screens intersecting the water table. After monitoring well installation is complete, a groundwater sample will be taken from each well. In addition, two existing monitoring wells (82MW30 and 82MW31) will also be resampled. These locations for the new monitoring wells, in conjunction with the existing wells, will provide an overall assessment of groundwater quality. In addition, data on monitoring wells located at IAS Site 6 will be provided by the Department of the Navy prior to the preparation of the Site Inspection Report. A round of samples is scheduled to be collected and analyzed in January of 1991 by ES&E. Of particular interest are wells 06MW01, 06MW03, 82SU651, and 82SU653, as shown in Figure 6-5. Information from this well will provide useful data in the investigation of Site 82.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. These samples will be be sent to the laboratory for chemical analysis. These samples will provide additional data on the spatial distribution of contamination at the site.

6.3.3 Soil

Six 15-foot-deep soil borings are proposed for this site, at the approximate locations shown in Figure 6-5. Two will be located on the north side of Wallace Creek to confirm that there are no sources in that area. The remaining four will be distributed along Wallace Creek and throughout the potential dump area with one located far enough upstream to provide a preliminary indication of the lateral extent of the suspected source area. These borings will be located by the hydrogeologist in suspected areas of contamination to maximize detection of traget analytes if present.

Two soil samples will be collected from each of the borings and sent to the laboratory for chemical analysis. The samples are planned for the near surface interval and the zone immediately above the water table.

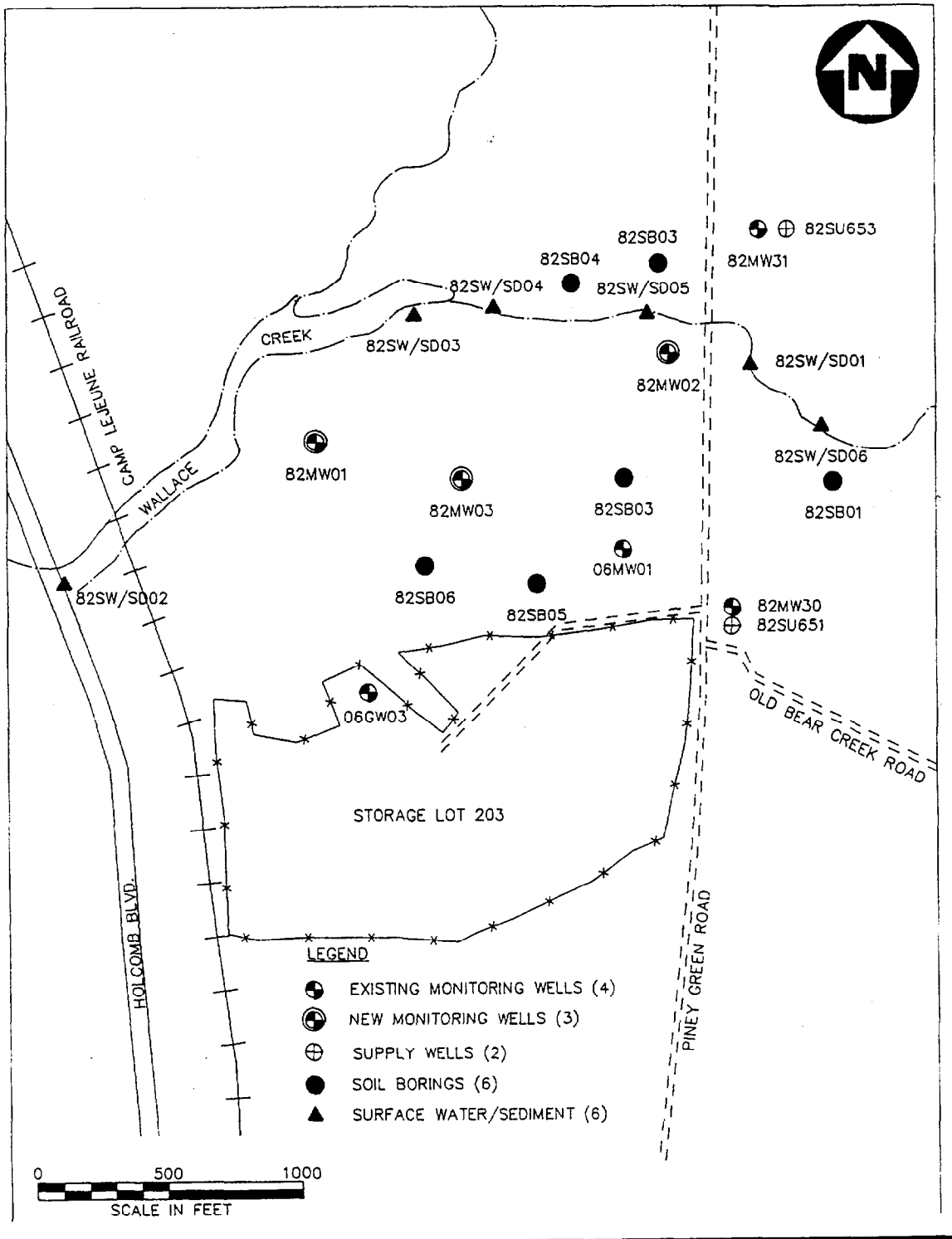

FIGURE 6-5
SAMPLE LOCATIONS
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE MILITARY RESERVATION

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6.3.4 Surface Water/Sediment

The intent of this task is to define the nature and extent of contamination in Wallace Creek that was first identified near Piney Green Road in 1986. Six samples will be required for this task. They will be distributed along Wallace Creek, at the approximate locations shown in Figure 6-5. Two will be collected above Piney Green Road and four will be collected downstream of the road, with a sample at Holcomb Boulevard marking the most downgradient location.

6.3.5 Analysis

All soil, groundwater, surface water, and sediment samples will be analyzed for the TCL volatile organics, pesticides and PCBs. These analytes are of concern at this site because they were detected during the previous investigation and will verify if this area of concern is a source for contamination.

6.3.6 Surveying

Upon completion of the field operations, monitoring well locations and elevations, soil boring locations, and surface water/sedimdent locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

6.3.7 Summary

Table 6-3 presents a summary of the proposed scope of work for the Piney Green Road VOC Area. Details on the particular activities are contained in Volume I of the Sampling and Analysis Plan.

TABLE 6-3

SUMMARY OF FIELD INVESTIGATION
SITE 82: PINEY GREEN ROAD VOC AREA
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Resample wells 82MW30, and 82MW31 • Collect 1 water sample from 3 new wells • Analyze 82MW1, 82MW2, 82MW3, 82MW30, and 82MW31 for: - TCL volatile organics - TCL pesticides - TCL PCBs	• Drill six 15-foot soil borings* • Collect 2 soil samples from eachboring • Collect 2 soil samples from each monitoring well boring • Analyze all for: - TCL volatile organics - TCL pesticides - TCL PCBs	• Collect 6 surface water/ sediment samples Analyze all for: - TCL volatile organics - TCL pesticides - TCL PCBs

* Locations contingent upon results of geophysical survey.

7.0 SITE 80: PARADISE POINT GOLF COURSE

7.1 SITE HISTORY AND PHYSICAL SETTING

The study area for this site consists of a 1-acre area at the back of the machine shop and the truck wash area at the Paradise Point Golf Course. The site contains an area of bare, hummocky soil, with a large soil mound. There are areas of dead and/or dying vegetation in the vicinity of the soil mound. In addition, there are unvegetated areas where soils have been disturbed. A drainage ditch runs from the truck wash area around the back of the machine shop and soil mound. Figure 7-1 presents a site map showing the major site features.

In addition to the machine shop, which is a potential source of waste oils, the routine application of pesticides and herbicides on the golf course and the potential inadvertent disposal of excess pesticides and herbicides behind the machine shop may also have contributed to potential contamination in this area. The truck wash area consists of a concrete pad and sumps that collect washwater from the sprayers. Prior to the construction of this pad, however, the disposition of washwater may have been completely uncontrolled. The presence of dead vegetation indicates that at a minimum, waste herbicides may have been disposed of behind the machine shop. There is no indication that other chemicals have been used or disposed of in this area.

7.2 INITIAL INVESTIGATION

As this is one of the newly identified sites, no previous field activities have been conducted at this site.

7.3 PROPOSED SCOPE OF WORK

The types of chemicals used in this area are rather well defined. Waste oils and possibly small amounts of solvents may have been dumped from the machine shop, and residual pesticides or herbicides may have been disposed of in this area in the past.

Figure 7-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes if present.

The field investigation at this site will be limited to sampling of soils, sediments, and surface water. The contaminants presumed to be present are highly immobile in the environment and tend to adhere to the organic carbon in soil. PCBs and pesticides have high organic carbon partition coefficients and low solubilities. Herbicides are slightly more soluble than the PCBs, but if present, they should be detectable in the soil. The scope of work is discussed in detail below.

7.3.1 Geophysics

Prior to breaking ground with the drill rig, each potential boring location will be surveyed with an electromagnetometer. This reduces the potential for encountering buried metal objects, particularly near the soil mound.

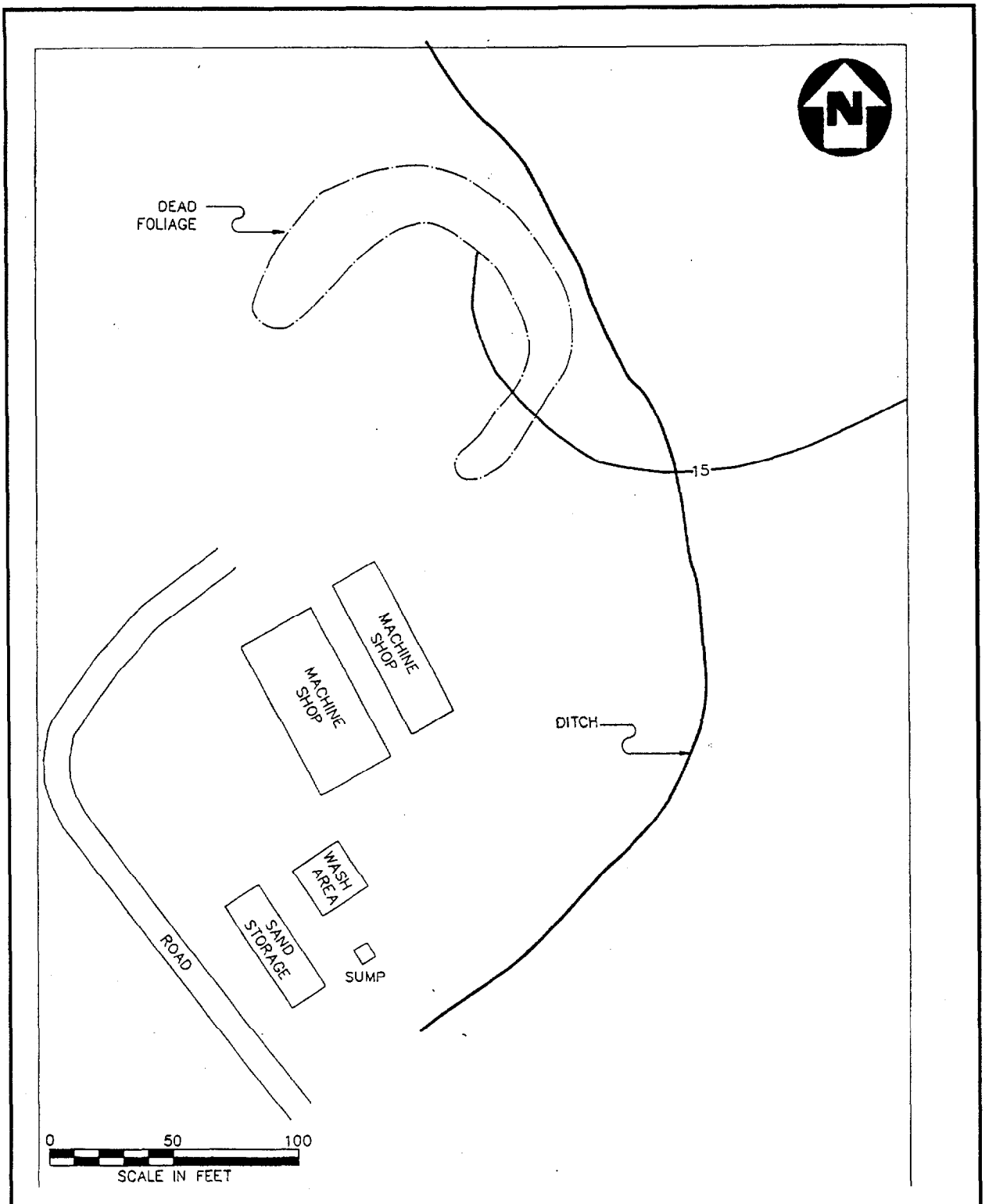

FIGURE 7-1
SITE 80: PARADISE POINT GOLF COURSE
CAMP LEJEUNE MILITARY RESERVATION

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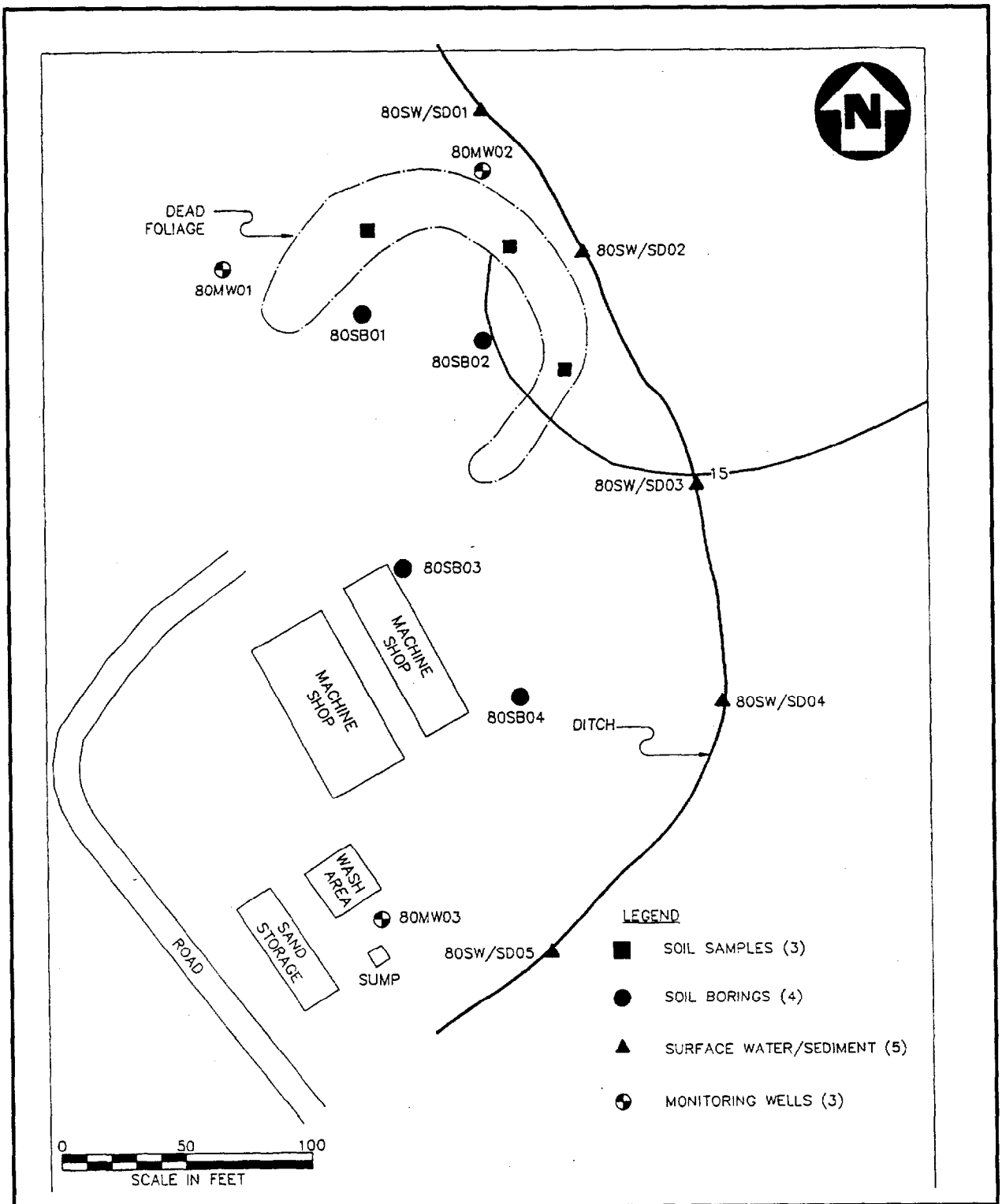


FIGURE 7-2
SAMPLE LOCATIONS
SITE 80: PARADISE POINT GOLF COURSE
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

7.3.2 Groundwater

Three shallow monitoring wells are proposed for this site. Groundwater flow direction is not known at this time; however, it is assumed the groundwater flows towards the north. Two of the monitoring wells are proposed behind the soil mound in the area of dead vegetation near the small stream. The other well is located near the wash area and its sump. Figure 7-2 shows the approximate well locations. It is also assumed that each well will be approximately 25 feet deep and that the screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

7.3.3 Soil

Four soil borings are proposed for this site. It is assumed that each boring will be approximately 15 feet deep, with a total of two samples collected from each boring for chemical analysis. Two borings are located behind the machine shop and two are located within the bare area.

In addition to the soil borings, three shallow subsurface soil samples will be collected on the soil mound near areas of dead vegetation. These samples will be collected by hand because the top of the mound is not accessible by a drill rig.

7.3.4 Surface Water/Sediment

Five sample locations are proposed for sampling in the drainage ditch that flows through the site. The locations were selected to provide a profile of the condition of the surface water and sediment in this area. Approximate sample locations are shown in Figure 7-2.

7.3.5 Analysis

Soil and sediment samples will be analyzed for the following parameters:

- TCL volatile organics
- TCL pesticides/PCBs
- Chlorinated herbicides
- Total petroleum hydrocarbons

Surface water samples will be analyzed only for the volatile organics and the petroleum hydrocarbons. The rationale for the proposed analytical suite for soils, sediments, and surface water follows.

Because so little is known about specific activities at the site, the list of TCL volatile organics is representative of the types of solvents that may have been disposed with waste oils. The presence of PCBs cannot be ruled out because of the varied uses and types of waste oils historically and presently found in the machine shop.

Golf courses routinely apply a variety of pesticides and herbicides to control insects and weeds on the fairways and greens. Although the sprayers are currently washed in a collection area, past practices are not known. The TCL list of pesticides and the list of common herbicides (2,4-D, 2,4,5-TP, etc.) should provide enough data for a risk assessment at the site.

Finally, total petroleum hydrocarbons are a good indicator of other types of oil/fuel contamination, and are therefore suggested for all media.

7.3.6 Surveying

When the field operations have been completed, monitoring well locations and elevations, soil boring locations, and surface water/sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

7.3.7 Summary

Table 7-1 presents a summary of the proposed scope of work for this site. The reader is referred to Volume I of the Sampling and Analysis Plan for the details on the conduct of the individual tasks outlined here.

TABLE 7-1

SUMMARY OF FIELD INVESTIGATION
SITE 80: PARADISE POINT GOLF COURSE
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect one water sample from 3 new wells • Analyze soil for: - TCL volatile organics - TCL pesticides/PCBs - Chlorinated herbicides - Total petroleum hydrocarbons	• Drill four 15-foot soil borings* • Collect two samples from each boring • Collect two samples from each monitoring well boring • Collect three shallow subsurface soil from mound area • Analyze all for: - TCL volatile organics - TCL pesticides/PCBs - Chlorinated herbicides - Total petroleum hydrocarbons	• Collect five surface water/sediment samples • Analyze all for: - TCL volatile organics - TCL pesticides/PCBs - Chlorinated herbicides - Total petroleum hydrocarbons

* Locations contingent upon results of geophysical survey.

8.0 SITE 3: OLD CREOSOTE PLANT

8.1 SITE HISTORY AND PHYSICAL SETTING

The old creosote plant operated from 1951 to 1952 to supply treated lumber during construction of the railroad on the base. The facility was located at PWDM coordinates 5, N11-12/O11-12, approximately 800 feet east of Building 613, on the opposite side of Holcomb Boulevard. Logs were cut into railroad ties at the onsite sawmill, then pressure treated with hot creosote stored in a railroad tank car. There is no indication of creosote disposal on site, and records show that creosote remaining in the pressure chamber at the end of a treatment cycle was stored for future use.

Upon completion of the railroad, the plant and mill were dismantled and sold. The only site features remaining are concrete pads and the boiler chimney. Figure 8-1 shows the approximate site configuration.

8.2 INITIAL INVESTIGATION

No previous field activities have been conducted at this site.

8.3 PROPOSED SCOPE OF WORK

Because no work has been conducted at this site, the field investigation is intended to provide a general indication of whether the potential for an environmental problem exists. The proposed analyses focus on contaminants commonly found at creosote facilities. Figure 8-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

8.3.1 Groundwater

Three shallow monitoring wells are proposed for this site. Groundwater flow direction is not known at this time. Two of the monitoring wells are proposed for the southern side of the site and one for the northern side, as shown in Figure 8-2. It is also assumed that each well will be approximately 25 feet deep and that the screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complte, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

8.3.2 Soil

Five soil borings are proposed for this site. The borings will be 5 feet deep because of the immobile nature of the PAHs and chlorinated phenols. Three soil samples will be collected above the water table during well installation to ensure that contamination has not migrated to deeper depths.

Two soil samples will be collected from each boring for chemical analysis. The specific depths and locations will be selected in the field; these are intended to provide a reasonable indication of the lateral and vertical extent of contamination, if present. Proposed boring locations are presented in Figure 8-2.

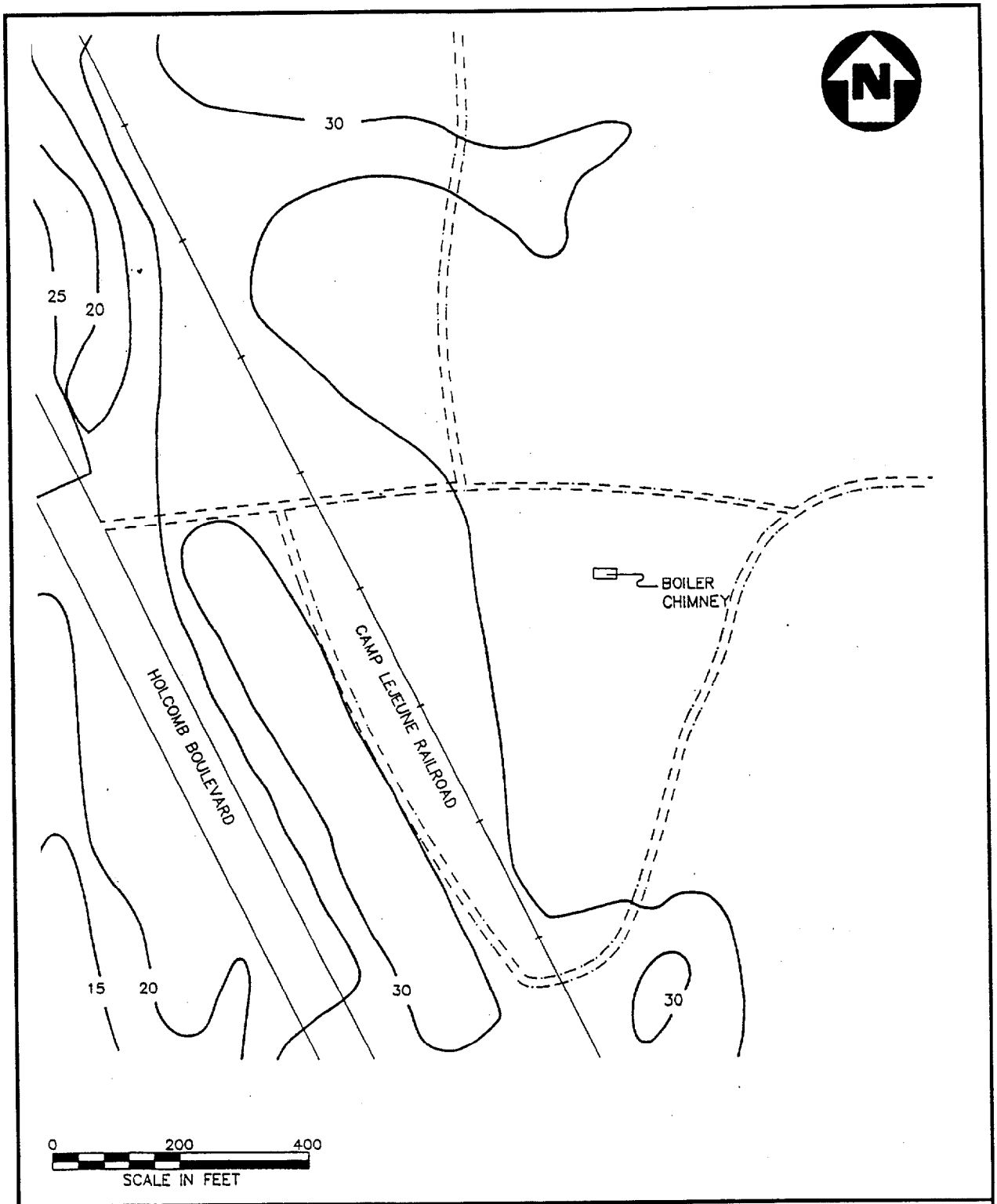


FIGURE 8-1
SITE 3: OLD CREOSOTE PLANT
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

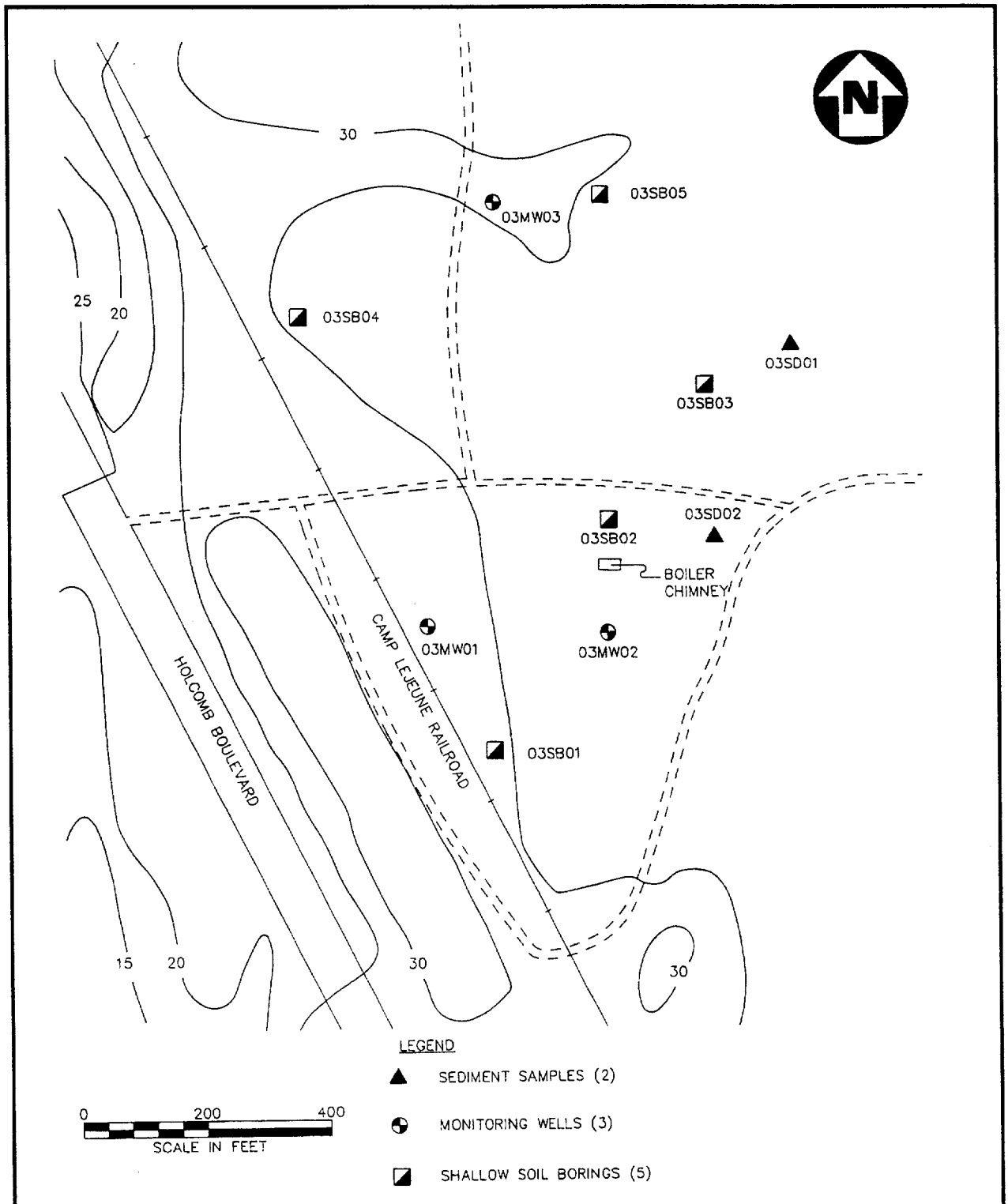


FIGURE 8-2
SAMPLE LOCATIONS
SITE 3: OLD CREOSOTE PLANT
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

8.3.3 Surface Water/Sediment

Two sediment samples will be collected from a nearby drainage ditch or potential wetlands areas for this investigation. No surface water samples are proposed because of the insoluble nature of the contaminants. Figure 8-2 shows the estimated locations. Final locations will be selected in the field.

8.3.4 Analysis

All the samples collected at the site will be analyzed for only the semivolatile fractions (acid extractables and base/neutral extractables) of the Target Compound List. Based on the known site history and a knowledge of other creosote facilities throughout the country, no other analytes are required.

8.3.5 Surveying

When the field operations have been completed, soil boring locations and sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map.

8.3.6 Summary

Table 8-1 presents a summary of the proposed scope of work for Site 3. Details on the field tasks are contained in Volume I of the Sampling and Analysis Plan.

TABLE 8-1

SUMMARY OF FIELD INVESTIGATION
SITE 3: OLD CREOSOTE PLANT
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect 1 water sample from all wells •Analyze all for: - TCL acid extractables - TCL base/neutral extractables	• Drill five 5-foot soil borings* • Collect two samples from each boring • Collect two samples from each monitoring well boring • Analyze all for: - TCL acid extractables - TCL base/neutral extractables	• Collect two sediment samples • Analyze all for: - TCL acid extractables - TCL base/neutral extractables

* Locations contingent upon results of geophysical survey.

9.0 SITE 43: AGAN STREET DUMP

9.1 SITE HISTORY AND PHYSICAL SETTING

The Agan Street Dump is about 20 acres in size and is located near the old wastewater treatment plant at PWDM coordinates 23, H6-7/I6-7. Boards, trash, fiberglass, and wastewater treatment plant sludge were disposed of on the ground surface. The years of operation are unknown. Figure 9-1 shows the general site configuration.

9.2 INITIAL INVESTIGATION

No previous field activities have been conducted at this site.

9.3 PROPOSED SCOPE OF WORK

The intent of the investigation at this site is to determine whether there is a potential for environmental contamination at the site. Because there are no existing data, the proposed analyses are more comprehensive. Figure 9-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

9.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed. All proposed boring and monitoring well locations will be surveyed using an electromagnetometer. This task is required to minimize drilling through buried drums or other metalic debris.

9.3.2 Groundwater

Three shallow monitoring wells are proposed for this site. Groundwater flow direction is not known at this time; however, it is assumed the groundwater flows east toward the New River. Two of the monitoring wells are proposed for the assumed downgradient direction and one for an upgradient location, as shown in Figure 9-2. It is also assumed that each well will be approximately 25 feet deep and that the screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

9.3.3 Soil

Five soil borings will be located throughout the site, with preference given to areas with visual signs of contamination. Tentatively proposed boring locations are shown in Figure 9-2. Two soil samples will be collected for chemical analysis from each boring, one near the ground surface and one in the zone immediately above the water table. This scheme will maximize the possibility of detecting potential contaminants.

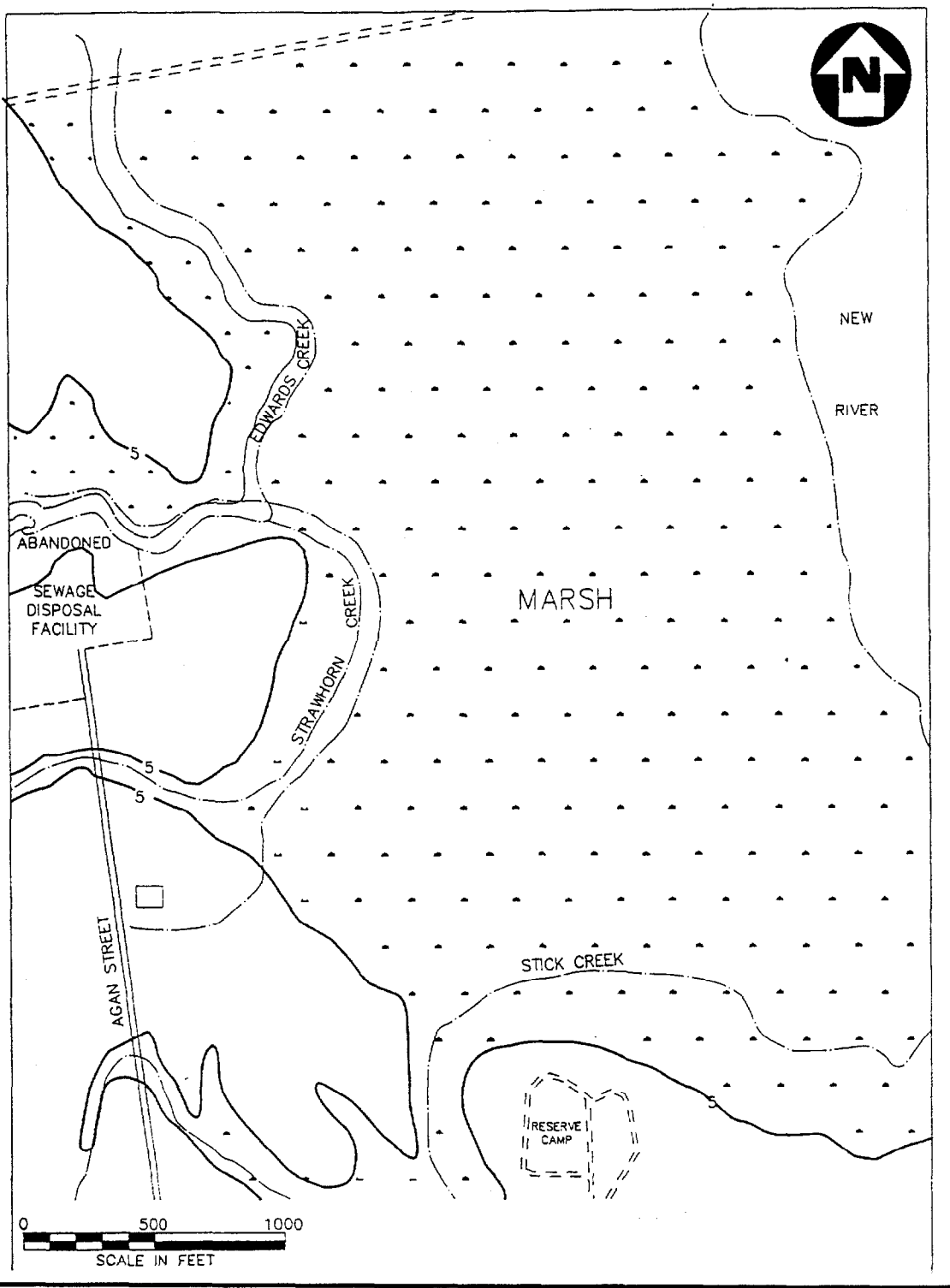


FIGURE 9-1
SITE 43: AGAN STREET DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

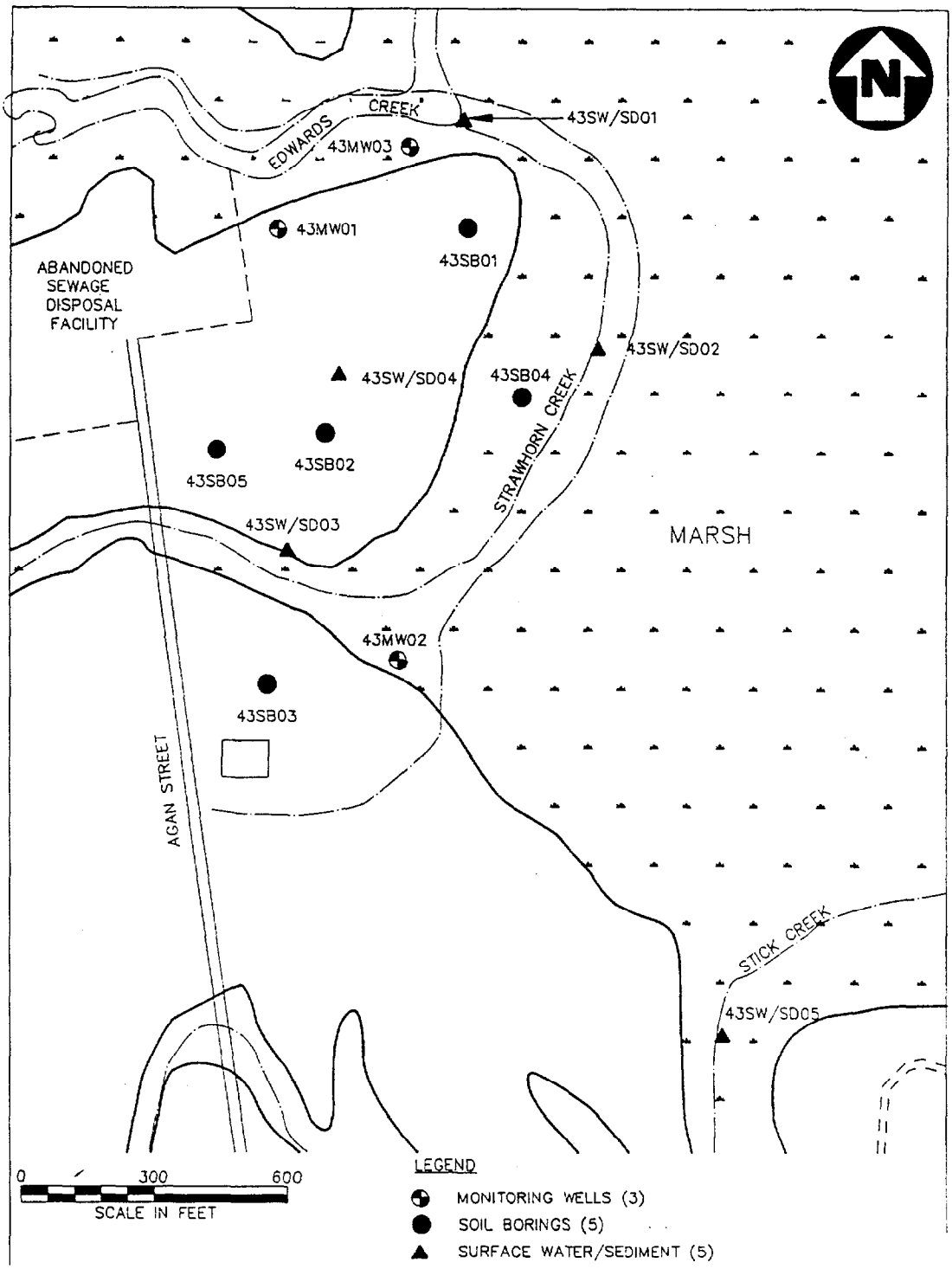


FIGURE 9-2
SAMPLE LOCATIONS
SITE 43: AGAN STREET DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

9.3.4 Surface Water/Sediment

Five surface water/sediment sample locations, as shown in Figure 9-2, are proposed for this site. Because there is some concern that contaminated soil could have been eroded from this site and deposited in the wetland areas or the streams, exact locations will be selected based on likely deposition areas.

9.3.5 Analysis

Because of the lack of information on specific disposal activities, a complete analytical scheme is recommended for this site. All samples will be analyzed for the full Target Compound List of organics and inorganics, including cyanide. The list of specific compounds this includes is located in Appendix A of this document.

9.3.6 Surveying

When the field operations have been completed, monitoring well locations and elevations, soil boring locations, and surface water/sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

9.3.7 Summary

A summary of the proposed field investigation for the Agan Street Dump is presented in Table 9-1. Complete information on the field activities is contained in Volume I of the Sampling and Analysis Plan.

TABLE 9-1

SUMMARY OF FIELD INVESTIGATION
SITE 43: AGAN STREET DUMP
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect 1 water sample from all wells • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Drill five 15-foot soil/ borings* • Collect 2 samples from each boring • Collect 2 samples from each monitoring well boring • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Collect 5 surface water/sediment samples • Analyze all for: - TCL organics - TCL inorganics, cyanide

* Locations contingent upon results of geophysical survey.

10.0 SITE 44: JONES STREET DUMP

10.1 SITE HISTORY AND PHYSICAL SETTING

The Jones Street Dump is located at PWDM coordinates 23, L6-7/M6-7 and is approximately 5 acres. It is located behind base housing on Jones Street. The dump was in operation in the 1950s, and received mainly debris, cloth, boards, and paint cans. However, small quantities of hazardous materials may also have been disposed of in the fill. The approximate site configuration is shown in Figure 10-1.

10.2 INITIAL INVESTIGATION

No previous field activities have been conducted at this site.

10.3 PROPOSED SCOPE OF WORK

Because no work has been conducted at this site, the field investigation is designed to determine whether there exists a potential for environmental contamination at this site. The proposed analyses are more comprehensive than at other sites with better defined site histories. Figure 10-2 provides approximate drilling and sampling locations. Final sample locations will be determined in the field by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

10.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed. All proposed boring and monitoring well locations will be surveyed using an electromagnetometer. This task is required to minimize drilling through buried drums or other metalic debris.

10.3.2 Groundwater

Three shallow monitoring wells are proposed for this site. Groundwater flow direction is not known at this time; however, it is assumed the groundwater flows north toward Edwards Creek. Two of the monitoring wells are proposed for the assumed downgradient direction and one for an upgradient location, as shown in Figure 10-2. It is also assumed that each well will be approximately 25 feet deep and the screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

10.3.3 Soil

Six soil borings (approximately 15 feet in depth) are proposed at the locations shown in Figure 10-2. The intent of these borings is to provide good spatial coverage of the site by filling in information from the areas not covered by the wells. Final locations will be determined in the field, with preference given to those locations that have obvious visual signs of contamination.

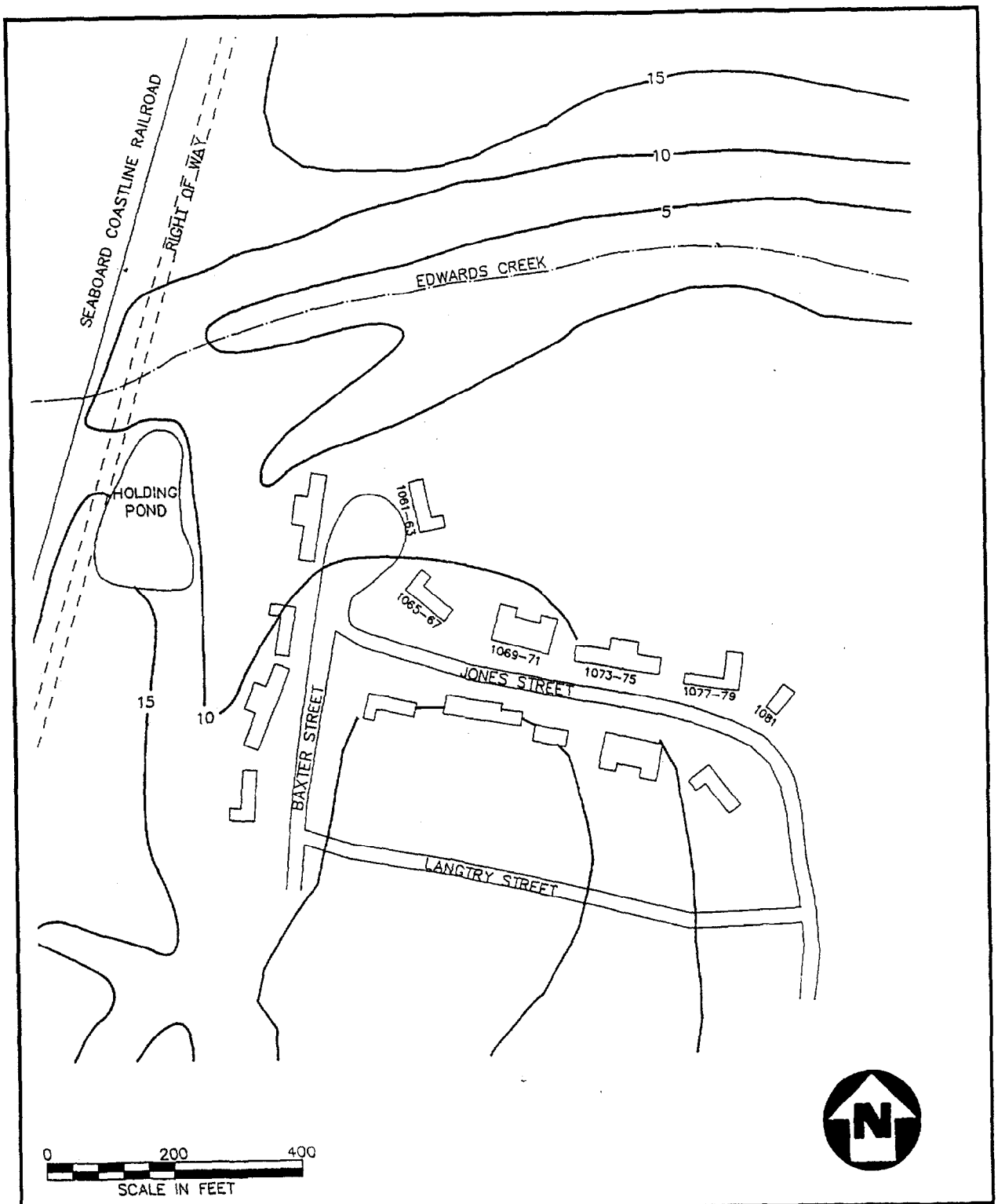


FIGURE 10-1
SITE 44: JONES STREET DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

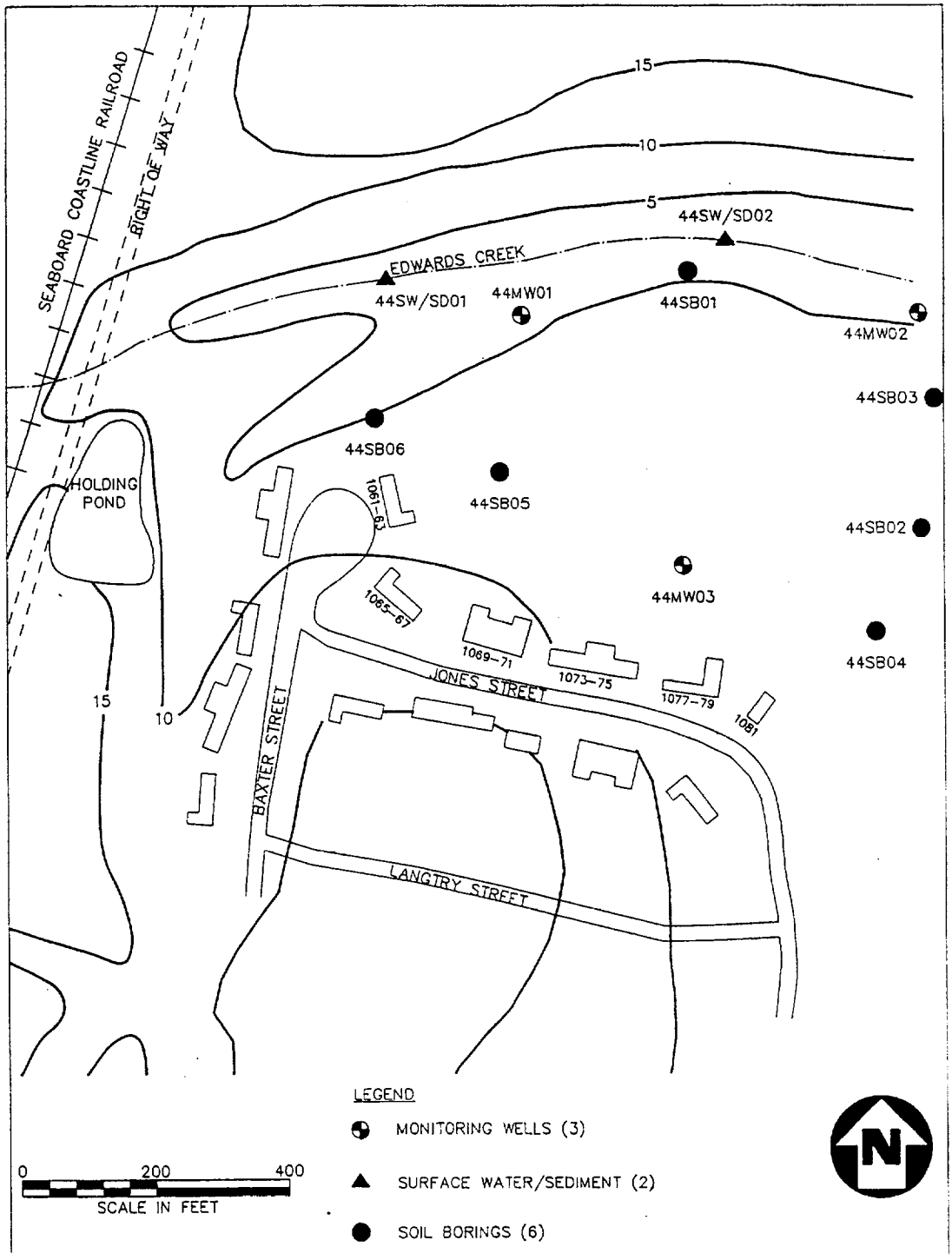


FIGURE 10-2
SAMPLE LOCATIONS
SITE 44: JONES STREET DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

10.3.4 Surface Water/Sediment

Two surface water/sediment sample locations, as shown in Figure 10-2, are proposed for this site. Because there is some concern that contaminated soil could have been eroded from this site and deposited in Edwards Creek, exact locations will be selected, based on likely deposition areas.

10.3.5 Analysis

All soil and groundwater samples collected from this site will be analyzed for TCL organics and inorganics, including cyanide. This complete analysis was selected because the precise nature of site disposal activities is not known, and this list of contaminants provides an adequate basis to determine potential human health and environmental risks. The specific compounds included in the TCL are located in Appendix A of this document.

10.3.6 Surveying

Upon completion of the field operations, monitoring well locations and elevations, surface water/sediment sample locations and soil boring locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

10.3.7 Summary

A summary of the proposed field investigation is presented in Table 10-1. Details on the particular tasks are contained in Volume I of the Sampling and Analysis Plan.

TABLE 10-1

SUMMARY OF FIELD INVESTIGATION
SITE 44: JONES STREET DUMP
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect 1 water sample from all wells • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Drill six 15-foot soil borings* • Collect two samples from each boring • Collect two samples from each monitoring well boring • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Collect 2 surface water/sediment samples • Analyze all for: - TCL organics - TCL inorganics, cyanide

* Locations contingent upon results of geophysical survey.

11.0 SITE 65: ENGINEER AREA DUMP

11.1 SITE HISTORY AND PHYSICAL SETTING

The Engineering Area Dump is located at PWDM coordinates 17, K16 and is 4 to 5 acres in size. Two separate disposal areas were identified: a battery acid disposal area and a liquids disposal area. The types of liquids involved are believed to be petroleum, oil, and lubricant products. In addition, the dump was used to burn construction debris. The dump was in operation pre-1958-1972. A general site map is presented in Figure 11-1.

11.2 INITIAL INVESTIGATION

No previous field activities have been conducted at this site.

11.3 PROPOSED SCOPE OF WORK

Two disposal areas have been identified from the available site information and the site visit. The proposed scope of work is designed to make a preliminary determination of the presence or absence of environmental contamination at the site. Complete analytical schemes are proposed to provide detailed information on the types of contaminants present. Figure 11-2 provides approximate drilling and sampling locations. Final sample locations will be determined by the project hydrogeologist. The hydrogeologist will locate samples in suspected areas of contamination to maximize detection of target analytes, if present. The scope of work is discussed in detail below.

11.3.1 Geophysics

Prior to breaking ground with the drilling rig, a surface geophysical survey will be performed. All proposed boring and monitoring well locations will be surveyed using an electromagnetometer. This task is required to minimize drilling through buried drums or other metalic debris.

11.3.2 Groundwater

Three shallow monitoring wells are proposed for this site. Groundwater flow direction is not known at this time; however, it is assumed the groundwater flows south toward Courthouse Bay. Two of the monitoring wells are proposed for the assumed downgradient direction and one for an upgradient location, as shown in Figure 11-2. It is also assumed that each well will be approximately 25 feet deep, and the screen will be installed to intersect the water table.

During well drilling, two soil samples will be collected from each boring, one near the ground surface and one above the water table. After monitoring well installation is complete, a groundwater sample will be collected from each well. These samples will be sent to the laboratory for chemical analysis.

11.3.3 Soil

Five 15-foot-deep soil borings are proposed for this site to provide some coverage of the site in areas without wells. Two samples from each boring will be collected and sent to the laboratory for chemical analysis. Proposed boring locations are shown in Figure 11-2. Final locations will be determined in the field after the geophysical survey and located in or near suspected areas of contamination.

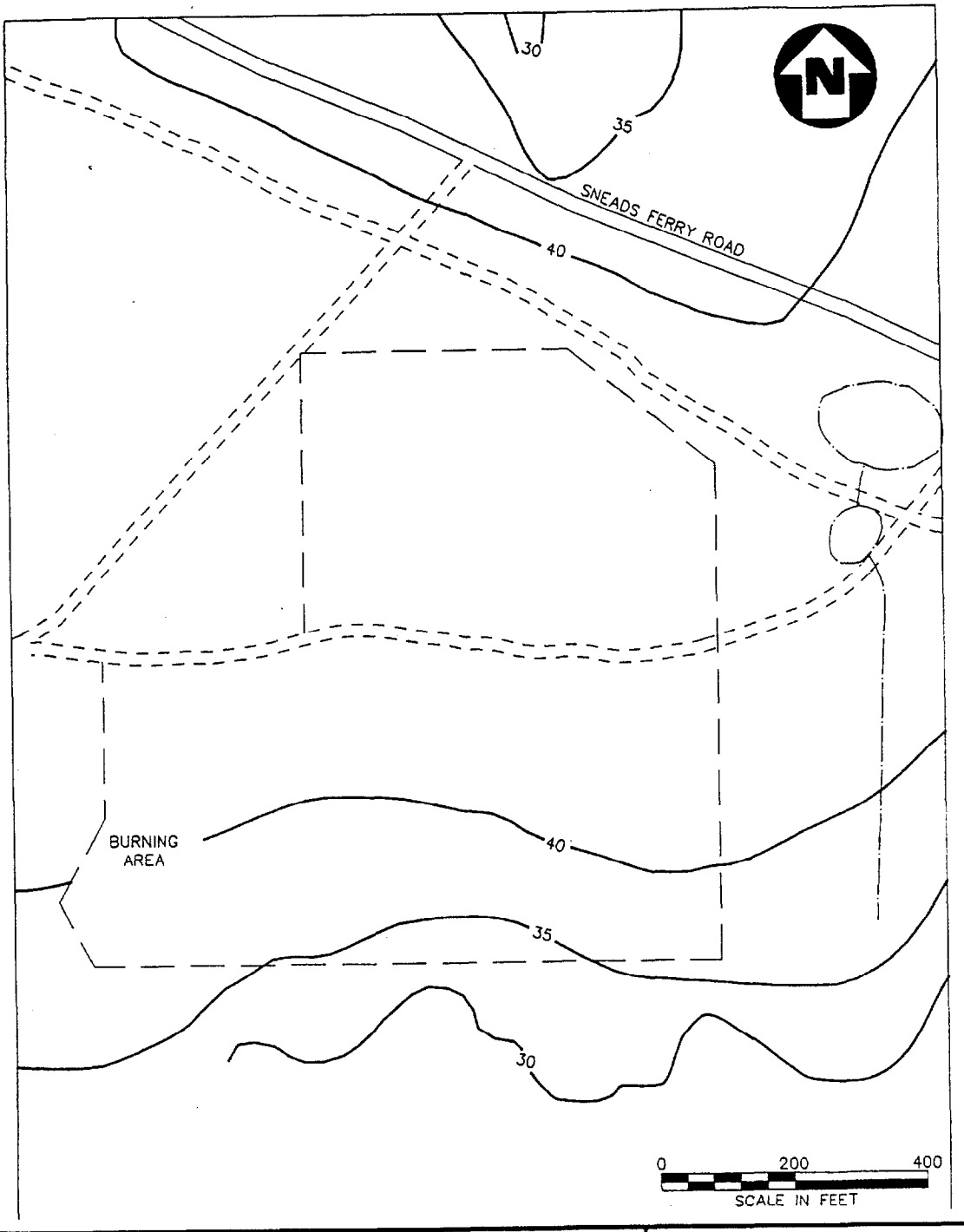


FIGURE 11-1
SITE 65: ENGINEER AREA DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

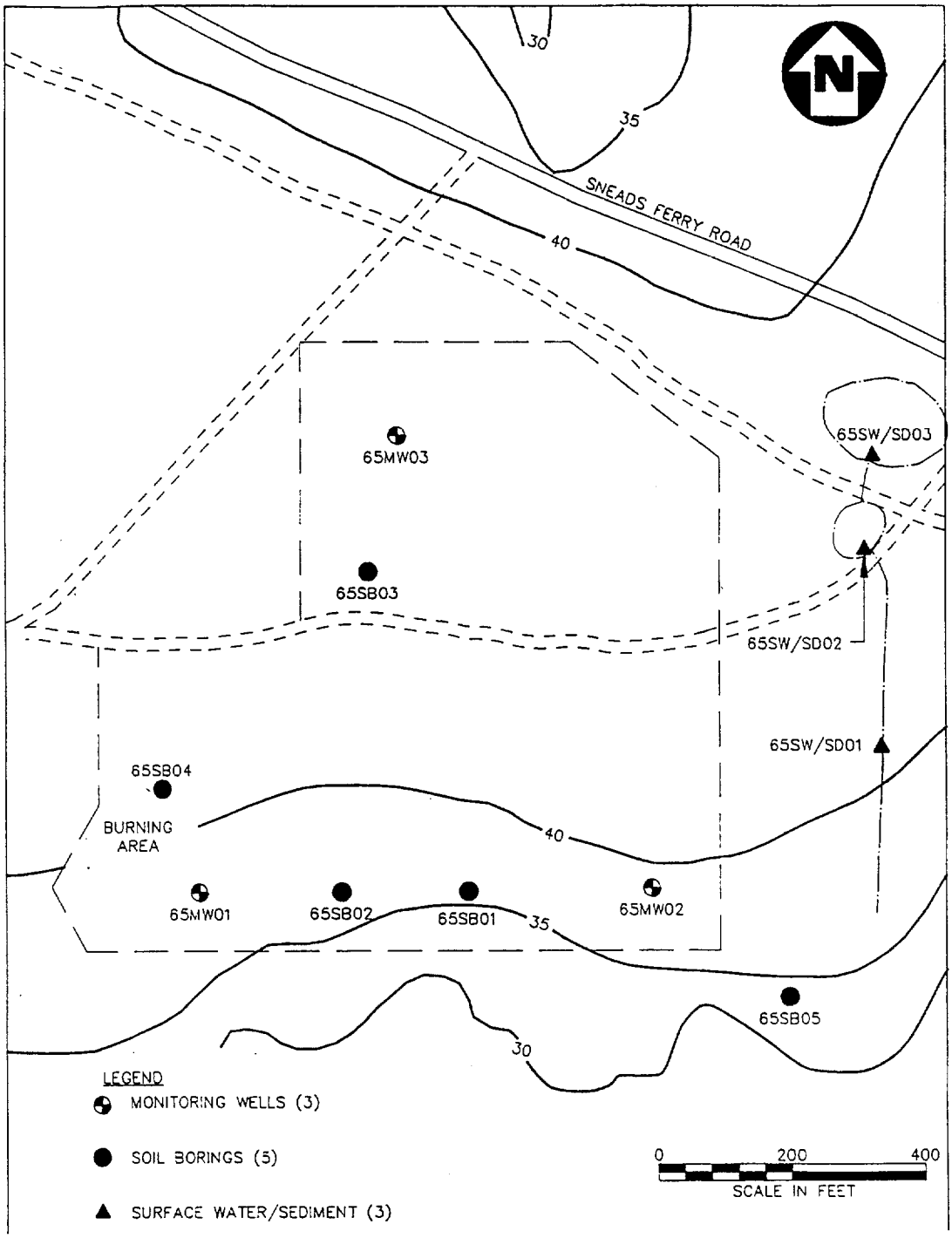


FIGURE 11-2
SAMPLE LOCATIONS
SITE 65: ENGINEER AREA DUMP
CAMP LEJEUNE MILITARY RESERVATION

NUS CORPORATION
A Halliburton Company

11.3.4 Surface Water/Sediment

Three surface water/sediment sample pairs are proposed for this site investigation. One pair is planned for the inlet to each of the two ponds, and the remaining one will be in the drainage ditch at the approximate location shown in Figure 11-2. These locations will provide an estimation of the lateral distribution of contamination that could be moving off site via the surface water.

11.3.5 Analysis

A complete analytical scheme is proposed for this site because of the uncertainty surrounding the disposal activities at this site. Therefore, all samples will be analyzed for the full TCL of organics and inorganics, including cyanide. The specific compound included in the TCL are located in Appendix A of this document.

11.3.6 Surveying

When the field operations have been completed, monitoring well locations and elevations, soil boring locations, and surface water/sediment locations will be surveyed by a licensed surveyor and plotted on an existing base map. Monitoring well elevations will include elevations for the ground surface as well as outer and inner casings.

11.3.7 Summary

Table 11-1 presents a summary of the proposed scope of work for this site. Additional details on the field activities are contained in Volume I of the Sampling and Analysis Plan.

TABLE 11-1

SUMMARY OF FIELD INVESTIGATION
SITE 65: ENGINEER AREA DUMP
CAMP LEJEUNE, NORTH CAROLINA

Groundwater	Soil	Surface Water/Sediment
• Install three 25-foot wells* • Collect 1 water sample from each well • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Drill five 15-foot soil borings* • Collect two samples from each boring • Collect two samples from each monitoring well boring • Analyze all for: - TCL organics - TCL inorganics, cyanide	• Collect 3 surface water/sediment samples • Analyze all for: - TCL organics - TCL inorganics, cyanide

*Locations contingent upon results of geophysical survey.

12.0 BACKGROUND SAMPLES

Three soil samples are proposed to provide an estimation of the background concentrations of metals in soils at the base. The samples will be collected from three different locations and will be analyzed for TCL inorganics (no cyanide) only. No organics analyses are required for the background samples because it is assumed that no organic chemicals are naturally occurring (with the exception of polynuclear aromatics in certain environments, such as bogs or coal deposits). These samples will provide a baseline to which the concentrations of metals at the various waste sites can be compared so that only metals that are truly present at elevated concentrations are examined in the risk assessment.

The locations of these samples have not been selected at this time, but the preferred locations will be in undeveloped areas of the base away from roads (because of the potential atmospheric deposition of lead) or from known or potential hazardous waste sites.

Background soil sample locations will be surveyed by a licensed surveyor and plotted on an existing base map. Additional details on the field activities are contained in Volume I of the Sampling and Analysis Plan.

13.0 PROJECT MANAGEMENT APROACH

13.1 ORGANIZATION AND APPROACH

The proposed project organization for the Department of the Navy, Camp Lejeune Military Reservation, is shown in Figure 13-1. The Program Manager, Ms. Vicki Bomberger, is responsible for the quality of all work performed for the Department of the Navy. Mr. Daryl Hutson will serve as the Project Manager (PM). The PM has primary responsibility for implementing and executing the Site Inspections. Supporting the PM are the Field Operations Leader (FOL) and other technical support staff. The FOL, Mr. Andrew Kendrick, is resonsible for the onsite management of activities for the duration of the field investigations.

The SI tasks included in this Work Plan comprise the baseline plans. These plans form an integrated management information system against which work assignment progress can be measured. The baseline plans are a precise description of how the work assignment will be executed in terms of scope, schedule, and budget.

13.2 QUALITY ASSURANCE AND DATA MANAGEMENT

The site-specific quality assurance requirements for the Camp Lejeune Military Reservation will be in accordance with the Quality Assurance Requirements Manual (QARM) developed by NUS, except where superseded by the Navy document entitled Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program (Naval Energy and Environmental Support Activity, June 1988). Requirements contained with the QARM conform to the provisions of the NUS Corporate QA Policy. A Quality Assurance Project Plan exists that supports this project and provides greater detail. All work performed will also comply with EPA Region IV QA/QC requirements.

To implement project work, a variety of technical and administrative Standard Operating Procedures (SOPs) have been developed. Examples of SOPs include health and safety procedures, environmental sampling, boring log preparation, and well installtion. Many SOPs, particulary field procedures, were prepared in accordance with EPA-approved procedures. The SOPs are located in Volume I, Appendix A, of the Sampling and Analysis Plan.

13.3 JUSTIFICATION FOR THE USE OF PVC WELL CONSTRUCTION MATERIALS

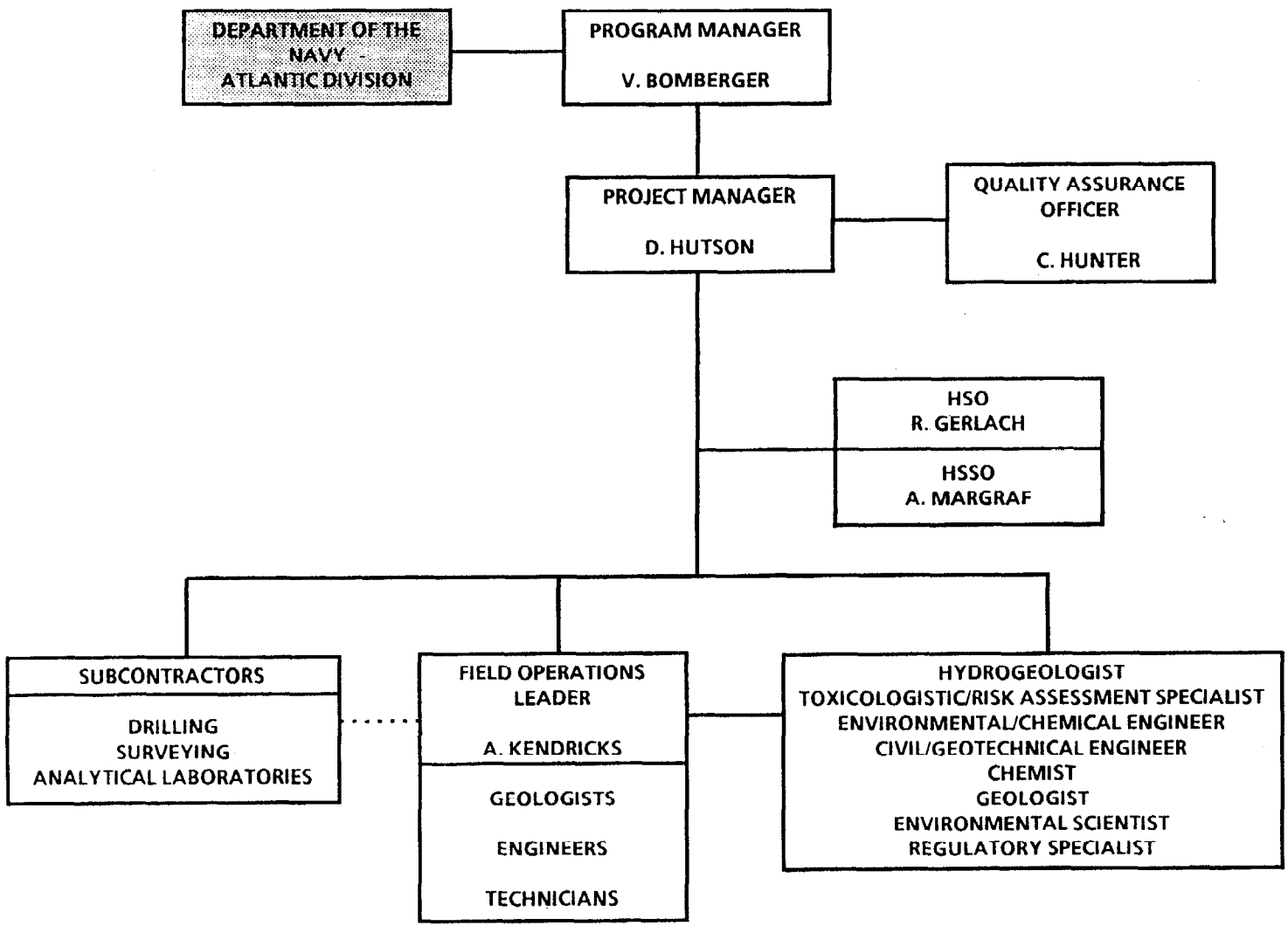
PVC has been successfully used for well construction at numerous Superfund sites, as well as for RCRA investigations. Literature is available to support is use with a variety of contaminants.

Based on known site history and prior sampling results, the majority of the sites at Camp Lejeune are thought to contain primarily volatile organic chemicals. However, there is one site that is expected to contain primarily PAHs, and another site that is a pesticide/herbicide site. However, most of the sites will be analyzed for a full spectrum of organic and inorganic contaminants on the Target Compound List.

PVC is considered to be the best compromise if both organic and inorganic pollutants are to be determined in groundwater collected from the same well (USATHAMA, January 1990). Teflon is more absorbent than PVC, and stainless steel oxidizes in the presence of water forming ferric hydroxides that can adsorb a variety of inorganics.

FIGURE 13-1

PROJECT ORGANIZATION
CAMP LEJEUNE
SITE INSPECTIONS



The major problems reported in the literature regarding the use of PVC have focused on the use of adhesives and sorption/desorption of organic chemicals in contact with the well material. No adhesives will be used in the construction process; only threaded PVC is proposed. Adhesives may contain a variety of ketones (4-methyl-2-pentanone (MIBK), 2-butanone (MEK), and cyclohexanone) and tetrahydrofuran (THF). These chemicals can mask certain Target Compound List chemicals. For example, MEK coelutes with 1,2-dichloroethane, THF coelutes with 1,1-dichloroethane, and cyclohexanone coelutes with bromoform. High concentrations of extraneous volatile organic chemicals can be found if new PVC bailers are used or if a well is not properly purged prior to sampling (Sosebee et.al., January 1982).

Purging of wells prior to sampling is essential to the collection of representative groundwater samples. Standard protocol calls for purging of at least three well volumes and continuing until pH, conductivity, and temperature are stabilized. These parameters are measured in the field and are recorded on sample log sheets. Samples are collected from all wells within 24 hours of purging. With this residence time of water in the wells, the literature reports no statistical differences are reported between wells constructed of PVC, teflon, and 316 stainless steel (Sykes et. al., 1986). This study used several volatile organics (monocyclic aromatics and halogenated aliphatics) at concentrations ranging from 87 to 150 µg/L, and measured the concentrations at the end of 1 hour, 24 hours, and 7 days, focusing on sorption of the spiked chemicals.

Additional support for the use of PVC comes from ARCO. Pieces of PVC screen were placed in three different pure gasolines for 6.5 months (Schmidt, 1987). At the end of that time, electron microscopy was used to evaluate the changes in slot size. No changes were observed between the control (in water) and the three samples placed in gasoline.

It is known that some compounds in pure or highly concentrated form affect the quality of PVC pipe (Watersaver). For example, more than 10 percent weight loss is reported within 1 to 28 days for PVC immersed in 100 percent methanol, JP-4, and kerosene, while significant deterioration is reported with pure toluene, trichloroethene, phenol, and benzene and concentrated sulfuric acid. No concentrations of this magnitude are expected at any site at Camp Lejeune. If pure product is found, well construction methods would be altered.

In addition to all the above points, PVC is more cost-effective and has been successfully applied by the Navy's contractor at Superfund sites in Regions I, II, and III; at RCRA sites in Regions I, II, III, and IV; and at military sites throughout the United States under the Air Force IRP program.

13.4 PROJECT SCHEDULE

The work identified in these documents is being performed by two contractors for the Department of the Navy. NUS Corporation will perform Site Inspections for the following:

- Site 3 - Old Creosote Plant
- Site 7 - Tarawa Terrace Dump
- Site 54 - Crash Crew Burn Pit
- Site 80 - Paradise Point Golf Course
- Site 82 - Piney Green Road VOC Area

Michael Baker Corporation will perform Site Inspections for the following:

- Site 43 - Agan Street Dump
- Site 44 - Jones Street Dump
- Site 63 - Verona Loop Dump
- Site 65 - Engineer Area Dump

The schedule for activities to be conducted by Michael Baker Corporation has not been finalized, however, it is anticipated to begin in the summer of 1991. A schedule will be sent to the members within the next few weeks.

NUS Corporation will initiate field activities on June 10, 1991. Field work will be completed by July 3, 1991. All analytical results will be received by mid-September (6 weeks turnaround of sample analyses) and validated by early October.

The Site Inspection Reports will be written and issued to the Navy for preliminary review prior to distribution. Draft copies of the five reports will be issued by mid January to the TRC for review. Final copies will be issued in February 1991.

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APPENDIX A

TARGET COMPOUND LIST OF ANALYTES

PESTICIDE ORGANICS

Compound	Compound
alpha-BHC	Methoxychlor
beta-BHC	Endrin Ketone
delta-BHC	Endrin Aldehyde
gamma-BCH (Lindane)	alpha-Chlordane
Heptachlor	gamma--Chlordane
Aldrin	Toxaphene
Heptachlor Expoxide	Aroclor-1016
Endosulfan I	Aroclor-1221
Dieldrin	Aroclor-1232
4,4'-DDE	Aroclor-1242
Endrin	Aroclor-1248
Endosulfan II	Aroclor-1254
4,4'-DDT	Aroclor-1260

INORGANICS

Compound	Compound
Aluminum	Magnesium
Antimony	Manganese
Arsenic	Mercury
Barium	Nickel
Beryllium	Potassium
Cadmium	Seleneium
Calcium	Silver
Chromium	Sodium
Cobalt	Thallium
Copper	Vanadium
Iron	Zinc
Lead	Cyanide

INORGANICS

Compound	Compound
Chloromethane	cis-1,3-Dichloropropene
Bromomethane	Trichloroethene
Vinyl Chloride	Dibromochloromethane
Chloroethane	1,12-Trichloroethane
Methylene Chloride	Benzene
Acetone	trans-1,3-Dichloropropene
Carbon Dilsulfide	Bromoform
1,1-Dichloroethene	4-Methyl-2-Pentanone
1,1-Dichloroethane	2-Hexanone
1,2-Dichchlorethene (total)	Tetrachloroethene
Chloroform	1,1,2,2-Tetrachloroethane
1,2-Dichloroethane	Toluene
2-Butanone	Chlorobenzene
1,1,1-Trichloroethane	Ethylbenzene
Carbon Tetrachloride	Styrene
Bromodichloromethane	Xylene (total)
1,2-Dichloropropane	

SEMIVOLATILE ORGANICS

Compound	Compound
Phenol	1,2,4-Trichlorobenzne
Bis(2-Chloroethyl)ether	Naphthalene
2-Chlorophenol	4-Chloroaniline
1,3-Dichlorobenzene	Hexachlorobutadiene
1,4-Dichlorobenzene	4-Chloro-3-methylphenol
1,2-Dichlorobenzene	2-Methylnaphthalene
2-Methylphenol	Hexachlorocyclopentaidene
2,2'-oxybis(1-Chloropropane)	2,4,6-Trichlorophenol
4-Methylphenol	2,4,5-Trichlorophenol
N-Nitroso-d-n-propylamine	2-Chloronaphthalene
Hexachloroethane	2-Nitroaniline
Nitrobenzene	Dimethylphthalate
Isophorone	Acenaphthylene
2-Nitrophenol	2,6-Dinitrotoluene
2,4-Dimethylphenol	3-Nitroaniline
bis(2-Chloroethoxy)methane	Acenaphthene
2,4-Dichlorophenol	

SEMIVOLATILE ORGANICS

Compound	Compound
2,4-Dinitrophenol	Di-n-butylphthalate
4-Nitrophenol	Fluoranthene
Dibenzofuran	Pyrene
2,4-Dinitrotoluene	Butylbenzylphthalate
Diethylphthalate	3,3'Dichlorobenzidine
4-Chlorophenyl-phenylether	Benzo(a)anthracene
Fluorene	Chrysene
4-Nitroaniline	bis(2-Ethylhexyl)phthalate
4,6-Dinitro-2-methyphenol	Di-n-octylphthalate
N-Nitrosodiphenylamine (1)	Benzo(b)fluoroanthene
4-Bromophenyl-phenylether	Benzo(k)fluoroanthene
Hexachlorobenzene	Benzo(a)pyrene
Pentachlorophenol	Indeno(1,2,3-cd)pyrene
Phenanthrene	Dibenz(a,h)anthracene
Anthracene	Benzo(g,h,i)perylene
Carbazole	